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The Capacity of a Glass Tank

By S. R. Scholes*

The question of how much salable glass can profitably be drawn from a given continuous tank is one that has gained a new interest in recent years, because of the increasing tonnages necessary for feeding automatic machines. The matter is not so simple as it appears at first thought. We cannot decide on exactly so many tons for so many square feet of melting area, until we gather data as to several important factors. Some of these are: the character of the glass melted; the class of ware being made; the ability of the tank to hold high temperatures with the fuel available; and the effect on the plant of prolonged shut-downs for rebuilding of tanks.

HIGH melting temperatures inevitably increase the rate of corrosion of clay walls; a compromise must be arranged between gain in melting time with higher temperatures, and saving the life of the blocks with lower temperatures.

. . . At this point the cost accountant and the production manager must get together and decide whether the increased production overbalances the more frequent rebuildings.

It is evident that the "soft-natured" glasses, more easily melted and refined, can be turned out in larger tonnages with the same fire, than can be obtained when stiffer glasses, lower in alkali, are being melted. However, since the greater number of factories making hollow ware are now melting the simple soda-lime batch on some approximation to the "100-40-10" basis, we may safely discuss the subject as regards such glass.

For this type of glass, furnace temperatures ranging from 2550° F. as a minimum to 2700° as a maximum are in use. These temperatures are considered as taken by optical pyrometer or some other means of ascertaining actual glass temperatures discussed so ably by A. E. Williams.[1] Just here, in the choice of temperature of tank operation, rests in large measure the answer to the question of tonnage. There is undoubtedly a marked increase in the fluidity of molten glass for every small rise in temperature throughout the above range. And the consequent rate at which bubbles rise and the glass "plains off" is accordingly greatly accelerated by, say, 50 degrees F. rise in temperature.

Not only do the bubbles trapped in the glass ascend more swiftly—or we might better say less slowly, for there is nothing rapid about their movement—but there is another advantage in the driving of tanks at higher temperatures, when tonnage is the aim. That is, when batch is melted rapidly, the gasses are evolved at a faster rate, and large bubbles are relatively more numerous than during the slower fusion. These large bubbles not only rise faster themselves, but sweep up with themselves many smaller bubbles that might otherwise hang back to come up more leisurely. There is thus a double gain in the application of more intense heat in the melting process proper.

One unfamiliar with glass tanks might therefore conclude that the highest temperature attainable with the furnace and fuel at hand would be the ideal condition. Unfortunately, the glass-house man knows only too well that the extreme of heat intensity that he may use is limited by what his refractories will stand. Thus we arrive at the crux of the whole question.

Glass tank refractories, out of contact with molten glass, are good for temperatures unheard of in melting practice, but the blocks retaining the glass have no such margin of endurance. From the first day of operation, the attack of molten glass on the blocks begins and continues steadily until it results in failure of the tank. The higher the temperature, the greater the rate of corrosion. Therefore some compromise must be arranged, between gain in melting time with higher temperatures, and saving the life of the blocks with lower temperatures.

American glass manufacturers are continually being told of the long life of glass tanks in use on the continent of Europe, where, it is claimed, several years elapse between rebuildings. In such statements, there is no mention of

* The Federal Glass Company, Columbus, Ohio.
[1] This JOURNAL, August, 1925.

temperature, size, or tonnage, so that we may feel justified in concluding that very little of the "wasteful" driving of tanks, such as we perform, takes place with these venerable tanks.

The point at which the drive for tonnage, by way of heat, becomes really wasteful, is one for the cost accountant to settle with the aid of the factory man's data. For example, if a certain tank of 300 square feet melting area is held for the duration of a fire at 2550°, or thereabouts, pulled at the rate of 20 tons in 24 hours, and lasts for 18 months, before general repairs become necessary, how does this compare economically with firing a tank of the same size at 2650°, pulling 30 tons each 24 hours, and wearing it out in a year?

It is commonly assumed that the tonnage of glass drawn from a tank determines its life. However, certain experiences show very clearly that, except as high tonnage necessitates high temperature, it is not the primary cause of block failure. Some tanks go out in six months, while others, with double the weight of glass melted per square foot of melting area, last ten months.

The principal point to be emphasized may be stated in terms of the old saw: you cannot have your cake and eat it. That is, if tanks are to be driven so that only ten square feet of melting area suffice for a daily ton of glass drawn, and clear glass of good quality must be produced, the melting temperature required will produce such a rapid corrosion of the clay walls that shorter life is inevitable. At this point, therefore, the cost accountant and the production manager must get together and decide whether the increased production overbalances the more frequent rebuildings.

Here it may be appropriate to remark that the tonnage "rating" of tanks means little, unless temperature of operating and character of product are specified.

There is one means of increasing capacity, in vogue in the days of pot furnaces, that has fallen into the disrepute it deserves. Reference is made to increasing the soda in the batch, so as to produce a softer and more fusible glass. It is now well understood that this proceeding makes glass that is so unresistant to the attack of atmospheric moisture that it will not stand either storage or use without acquiring a bloom.

A factor not to be overlooked in working for maximum tonnage is the method of charging. No doubt today's practice is weak on this point, for the ordinary method of filling charges of batch and cullet through dog-houses can hardly be sufficiently uniform in results to be ideal. Inasmuch as the flow of glass from the working end is continuous and practically uniform, the same continuity and uniformity ought to be maintained in charging, if the batch is always to have the same melting time. Where maintenance of constant glass-level is a prime requisite, as in the case of certain automatic machine operations, improved methods of charging are developed perforce. Under other circumstances, wide fluctuations in the rate of feeding are allowed to occur, with the consequence that periods of seedy glass are observed. For, when a tank is already flowing all the glass that can be plained in the time of plaining allowed, a surge in the charging rate must send through a quantity of glass too young to be fit for working. Nor can such a surge be entirely offset by lulls occurring before and after.

Linked with the question of tank capacity is that of fuel economy, or pounds of glass per pound of coal (or other unit of fuel measurement). Since few tanks lose less than 70% of the heat in the fuel burned, by radiation, and 20% more by way of stack gases, the more glass there is melted, the more nearly the remaining 10% of heat will be usefully employed. In other words, when the tank is not being charged, 90% as much fuel must be supplied as when it is being pulled to the limit. This means that when a well-operated tank is melting 40 tons on a coal consumption of 20 tons, or twice as much glass as coal burned, the actual heat entering the glass is furnished by 2 tons of coal. If the pull slackens to, say, 20 tons we may look for no appreciable diminution in the fuel fed, but a great reduction in efficiency.

Again, the effect of higher temperatures is cumulative, because the glass is heated to a greater depth, and consequently the flow takes place in lower levels that would remain practically stagnant at lower temperatures. Just how deep this flow may be is a matter for conjecture. Bits of evidence as to the total time of travel from dog-house to machines may be acquired. These indicate that certainly not over three-quarters of the entire mass of glass is in motion, even in a very hot tank, and probably not over one-half.

Part of this stagnation is to be attributed to the corners of the tank, where no motion takes place. But that a considerable body of glass, near the bottom, over practically the entire melting end, is not in motion, is shown by the fact that when a tank is cooled down and the glass mined out a layer of green glass is found. This is in depth from a few inches to a foot, depending on the temperature of operation. It is unlike the glass lately drawn from the tank for ware, and can only be the result of stagnation.

Regardless of the tank temperature, the velocity of flow must always be greatest at the surface. But much can be done toward equalizing the flow, between the speed of surface glass and that a couple of feet deeper, by operating at higher temperatures.

Enough has been said to indicate that the tonnage which it is profitable to draw from a tank reaches a maximum determined by the rate of block corrosion at the temperature required. Possibly the cost of the additional fuel necessary for maintaining the greater degree of heat may also enter in, but not to same extent as the cost of blocks destroyed and the loss of production during periods of repair.

Changing Properties of Glass by Heat Treatment

Results of investigations which have been carried on for the past two years by the Bureau of Standards, Department of Commerce, show that by changing the heat treatment of glass during the process of manufacture, the density and refractivity may be materially altered, and other properties can be greatly changed.

Since the physical properties of glass are subject to changes of considerable magnitude during the final stages of production, even when the composition and methods of melting are carefully controlled, these results will prove valuable in many problems in the manufacture of both optical and commercial glasses, including bottles and window glass.

Safe Thinking and Safe Clothing at the Glass Works*

By John M. Sandel†

This story is concerned chiefly with the hazards connected with the manufacture and handling of glass and how they have been overcome in the plants of the Pittsburgh Plate Glass Company.

In addition to its own special hazards, glass making involves those common to all industries. A review of the causes of accidents to employees of the Pittsburgh Plate Glass Company shows that the majority of accidents are not caused by the breaking of glass but by falls, slipping, tripping, tools, operation of machinery, handling materials of all kinds—in fact, those causes which require the attention of safety organizations in all large plants.

The company has been actively engaged in safety work for the past ten years. The steady campaign to reduce accidents has been increasingly successful and the safety organization in each plant has developed a fine spirit of teamwork. The details and methods of accident prevention work have improved as interest has grown. About two years ago the safety program was reorganized so that intensive work was on the program for employees of every department. Since then remarkable progress has been made. With

HEAD AND SHOULDER PROTECTION

for employees carrying large pieces of plate glass. The man in the center is wearing the old type of protective clothing. Those on the right and left are wearing protectors made of heavy felt pad one inch thick covered with heavy chrome leather. This equipment affords protection not only to the shoulders and chest but also to the head. It was developed by the men themselves and, since its introduction, no injuries have occurred.

a working force ranging from 7,900 to 8,800 during the two year period the frequency of lost time accidents per hundred employees has dropped from 1.34 to .54. The frequency and severity rates for all plants in 1924 were respectively, 29 per million hours worked, and 1.022 per thousand hours worked. The battle for accident prevention is on in earnest. Everyone is thinking safety while making glass.

The methods of carrying on the work in the nine plants of the company are essentially the same, and it was our privilege to visit Works No. 4 at Ford City, Pa. This is one of the largest plants of the company, employing an average of two thousand men during the last two years. During that period, the number of lost-time injuries per one hundred employees has dropped from 1.78 to .42, and for the majority of the time the ratio has been less than one lost-time injury for one hundred employees. Engineering revision, plus excellent cooperation between employees and supervisors, has accomplished this notable reduction.

HEAD AND FACE PROTECTION

provided for girls working at the annealing furnaces. The mask (at the right) replaced the goggles and cheesecloth formerly worn and it has proved exceptionally satisfactory.

A little more than six years ago while safety engineer for a firm of consulting engineers I visited this same plant. During the interim, the company has greatly improved the physical condition of the plant. Excellent safeguards have now been provided for such exposures as belts, pulleys, etc., and safe passageways to all parts of the plant have been constructed. Nearly all of the buildings are of one story construction, but there are differences in levels between different departments. The erection of elevated runways over depressions in a few locations has served to expedite and make safe pedestrian travel over the transfer tracks between. The walkway erected over a portion of the grinding and polishing tables, with access to the rouge grinding department has been an excellent improvement, as most of the men coming into the plant will use this walkway and they are naturally diverted from the hazardous transfer car traffic in a somewhat noisy department.

The company maintains a large and well guarded machine shop at Ford City, which supplies all plants with much of their equipment. All of the machine tools having cone pulleys have been equipped with cone pulley belt shifters. Workmen operating grinding wheels or chipping castings wear goggles when engaged in this hazardous work. It has required quite a campaign to secure the cooperation of employees in wearing goggles, but the company has no difficulty in doing so now.

Drill press tables have been equipped with vises to hold

* By courtesy of the National Safety Council and National Safety News.
† Safety Engineer, National Safety Council, Chicago.

the work in place. This makes it easy for the workmen to clamp stock on the table. The vise is of such a design that it can be turned in several directions. There are a number of operating advantages through the use of this vise.

The increase in size of equipment used in the plants has required increasing the size of one of the large planers in the machine shop, until it is now fourteen by thirty-two. When the additions to the ways of the planer were installed, the extreme travel of the table came very close to the wall of the building, increasing the possibility of a man being pinched between the planer table and the wall. To reduce this hazard, the portion of the wall back of the planer was torn out and a double hinge door erected. If the planer table now strikes the door it will open outward, and should a man be between the two, he would not be injured.

The company has provided excellent toilet and washroom facilities. The majority of the work in the plants is dirty work, and the washroom facilities are much appreciated by employees. Water for shower baths is now heated by exhaust steam, which is much safer than the gas heaters which were formerly used. Water heaters of the instantaneous type were used, but since these are hazardous because of the possibility of the pilot light being extinguished and allowing gas to escape, the gas heaters were dispensed with.

In one portion of the laying yard, there was scant clearance between tables for the grinding and polishing wheels and the wall of the building. In order to increase this clearance, heating radiators along the wall were raised four and one-half feet above the floor, to provide plenty of clearance for a man between the wall and the table.

It was formerly the practice at the close of the day for the men employed in the plaster house to use the compressed air hose to blow the dust off their clothes. To reduce this hazard, the company provided a vacuum cleaner.

The cutting table back of the lehr has been equipped with wire brushes in front of the wheels, which serve a dual purpose. They brush small pieces of broken glass off the tracks, and deflect the feet of any employees who may be in the way. As the sheets of glass are removed from the table by crane, the table is raised by compressed air to facilitate the operation. Because the table moves, it is necessary to connect the air line when the table is moved to the point where it is desired to be raised. At this point, a special valve has been placed in the air line so that the air pressure is diverted away from any employee who fails to shut off the air before uncoupling the air hose. This is an important safety provision.

A few of the cranes in the plant have the lowest chord of the girder convex, so that there is considerable depth to the girder at the center. A few of the cranes with such girders have the cab traveling with the trolley, but formerly when the operator got to the center, he did not have a clear vision of the runway. The cabs were lowered to provide this.

In the laying yard, one of the passageways leads to a section of the yard where one of the cranes is operating constantly, carrying large sheets of glass. As the crane approaches this particular passageway, an electric warning sign lights and a bell rings.

Glass in sheets is lifted by the cranes by a clamp or hook of the ice tong type. Most of the present clamps open when a man on the floor pulls a rope attached to the tong, and they close when the rope is released. The man on the floor is subject to some hazard because some grades of glass will break if the clamp closes too suddenly or if the crane operator lifts his load suddenly. To overcome the hazard to the man on the floor, the company has developed a new hoisting clamp, which does not require a floor man to handle whenever a load must be lifted or released.

After the glass has been cast and rolled into a sheet, it is pushed into the lehr by stowing machines. The operator stands close to the lehr and has a single lever for the control of the machine. He is thus located far away from the switchboard and not subject to flashes from circuit breakers and switches as was the case years ago. The control boards have been enclosed so that passers-by will not be burned by arcs or flashes.

Conditions in the yard have greatly improved. Storage piles of all kinds of material are better regulated and the roads most frequently used are paved. Mirrors of large size have been provided on the outside of curves of the roads so that drivers can see traffic that is approaching them from around a blind corner. This has eliminated collisions between vehicles in the yards.

Bubbler drinking fountains have been provided all over the different plants. To supply men on construction work with as good drinking water as men in the plants are supplied with, the water pail illustrated was developed. It would have been impossible to install temporary drinking fountains on this particular job, so the closed pail was provided with a container on the side for flat paper cups. When the pails were empty and sent down to the ground for refilling, a new supply of paper cups was placed in the side pocket, and the results were very satisfactory.

The greatest stride that has been made in the work of preventing accidents has been in the development of clothing to protect workmen from breaking glass, with the result that injuries from glass cuts are now rare. The company has found it necessary to develop special protection for different parts of the body of workmen, as the hazard of breaking glass required special consideration. They have carried on their experiments for a long time, and now feel that the various styles of head, face, arm, knee, and a leg protection are indeed satisfactory. Undoubtedly, these articles of clothing have been a big factor in reducing accidents at all of the plants.

In the operation of annealing or heat treating furnaces in the optical glass department, girls formerly wore goggles and wrapped cheese cloth around their heads and faces. These furnaces are small, and the openings are on a level with the shoulders. A wire mask was developed to protect the faces of the girls, and this has proved more satisfactory than the use of goggles and cheese cloth. It is much more comfortable than the old protection.

Most employees handling glass sustain cuts on the arms and hands. For a long time, cuffs of various styles have been worn in all plants. They are similar in appearance to cuffs worn by retail butchers, but they come much higher on the arm. The first cuffs used were of stiff leather, some of which were reinforced with steel or brass studs. This cuff was unsatisfactory because it caused an irritation of

the employee's wrists, and small pieces of glass would get between the wrist and the cuff and cause a cut. The stiff leather was readily cut by the sharp points of the glass. The present development is a chrome leather cuff which is fastened by buckles and reinforced with steel staples. This flexible leather cuff is very satisfactory.

Men employed as glass cutters are given quite complete protection. The man in the illustration is wearing goggles, arm protectors, and a heavy leather apron, special knee pads, and foot protectors. The foot protectors are made of chrome tanned leather reinforced with steel staples similar to the arm protectors. The company reports that there have been no foot injuries when these protectors have been worn. The method by which the knee pad is fastened to the trousers prevents any piece of glass entering over the top of the pad and causing injury to the knee. The foot protectors are permanently attached to the shoe, as the company has found that loose foot protectors were difficult to keep in position on certain operations and that men objected somewhat to the foot protection during the warm weather. The company buys the congress type of shoes, attaches the foot protection, and sells them to employees at less than one-half the cost of both. The protected and unprotected shoes are also shown in an accompanying illustration.

PERSONAL PROTECTION PROVIDED FOR GLASS HANDLERS AND CUTTERS

Wrists and arms are protected by chrome leather cuffs having staples across the surface. Shoes are provided with a similar cover across the front of the upper and the toe. No foot injuries have been reported when these shoes have been worn. The aprons are of crome leather. The knee pads worn by the man are attached so that glass cannot fall between the pad and trousers. Equipment is used to provide good drinking water to employees on construction work. The can has a pocket in the side for individual paper drinking cups.

In some cases, employees must carry large sheets of plate glass. Formerly, the only protection that employees had was a felt pad placed loosely over one shoulder. Now the company has provided heavy felt pads one inch thick covered with heavy chrome leather for each shoulder and the head, as shown in the accompanying illustration. This was developed by the men themselves and has proved satisfactory. Since its introduction, no injuries have been received by employees doing this kind of work.

In addition to silver loving cups offered by the company for interplant competition, a silver loving cup has been offered by each plant as a trophy for departmental safety competition. It is awarded monthly to the department making the greatest reduction in accidents over the same month of the previous year. Another trophy is awarded quarterly to the plant making the greatest reduction over the same quarter of the previous year.

For the individual employees, safety watch fobs were awarded for the year 1924 to every member of a group or department going through the year without a lost-time accident. Each fob was engraved with the individual's name. About 900 safety fobs were given as rewards for individual effort and to encourage team work.

The cooperation secured from employees and members of the department safety committees has been a big factor in the good safety records. Teaching the men to think has been the result of many years work through bulletins and personal contact. Plant superintendents and foremen are now taking an active interest in safety and are leading their men in securing the good results.

Raw Materials of the Glass Industry

V. Limestone, Burnt and Hydrated Lime

By J. B. Krak, Technical Editor

Lime is one of the three major constituents of the common varieties of glass such as window, plate and bottle glass. It plays the part of the stabilizing compound. A glass made by the fusion of sand and soda ash is soluble in water. Addition of a sufficient amount of lime renders glass insoluble, resistant against chemical action and against weathering. Within certain limits the resistance of the glass against atmospheric influences is proportional to the amount of lime present. Increase in the percentage of lime causes a marked increase in the elasticity.[1]

A soda-lime glass of great stability and mechanical strength is one having the following composition:

Silica (SiO_2)	71.50 per cent
Alumina (Al_2O_3)	1.50 " "
Sodium oxide (Na_2O)	14.00 " "
Lime (CaO)	13.00 " "

Much window glass, made by hand or by the cylinder process, has a composition that does not differ materially from the above. Window glass made by the Libbey-Owens and that made by the Fourcault process, and also bottle glass made by machinery, is composed so as to run lower in lime and higher in sodium oxide and silica. These glasses are made much softer, for the sake of mechanical devices. Experience has shown that low lime-high sodium oxide glasses melt quicker, which increases production. These glasses do not set as rapidly as those in which the amounts of lime and sodium oxide are more nearly the same. The annealing temperature of glass low in lime is lower than that of a high-lime glass. Therefore, less time is required to carry out the annealing process.

However, all these advantages have been obtained somewhat at the expense of the mechanical strength of the product and of its resistance to chemical corrosion.

The amount of lime in glass should not run much below 7½-8 per cent, nor should the sodium oxide exceed 18 per cent. This applies especially to bottle glass.

Raising the amount of lime above 13½ per cent first increases hardness and brittleness. Further increase in the lime content may cause the formation of cords and devitrification.

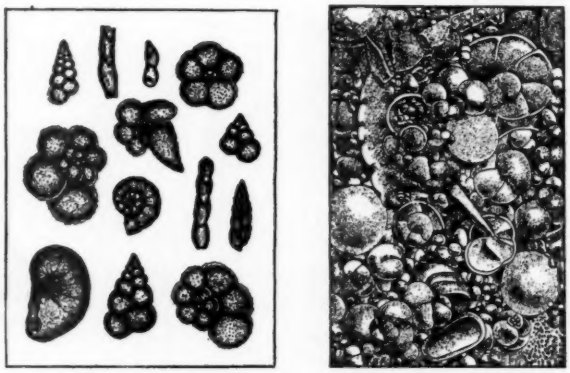
Lime may be introduced into glass in three ways: (1) by using carbonate of lime (calcium carbonate, $CaCO_3$) in one of its various forms as limestone, limespar, marble or chalk; (2) in the form of burnt lime (calcium oxide, CaO); (3) as slaked lime (calcium hydrate, $Ca(OH)_2$.)

Geology of Limestone

The primary source of limestone is to be found in the decomposition of the original igneous rocks, composing the earth by the action of carbonated water.[2] This results in the formation of bicarbonate of lime which passes into solution in the ground water, springs and streams and is hence withdrawn by a variety of processes. Some limestone deposits show evidence of being formed by chemical deposition, by the following reaction:

$$\underset{\text{bicarbonate of lime}}{CaH_2(CO_3)_2} = \underset{\text{carbonate of lime}}{CaCO_3} + \underset{\text{water}}{H_2O} + \underset{\text{carbon dioxide}}{CO_2}$$

This equation indicates that water-soluble bicarbonate of lime is changed into insoluble limestone, water and gaseous carbon dioxide. Huge deposits have been formed in this manner. In the limestone caves of Kentucky the formation of stalagmites and stalactites by precipitation of carbonate



MICROSCOPIC VIEWS OF CHALK

of lime from percolating water affords an example of lime rock building by chemical means.

However, the great majority of limestone deposits are undoubtedly of organic origin; that is to say, the transfer from solution to the solid state has gone through the medium of living organisms. Foraminifera, corals, the thousands of species of shell-bearing animals which have populated the seas from the beginning of the Palaeozoic era up to the present time have formed, and are still forming, limestone deposits. These organisms assimilate the dissolved calcium present in the sea water and convert it into shells and other parts of their bodies. Through millions of years the myriads of these animals have contributed their remains which have sunk to the bottom of the ocean to form enormous deposits.

When other sediments are laid down on top of them, these calcareous layers, by pressure, become compressed and more or less recrystallized, forming limestone rock. Through upheavals of the earth's crust the deposits, laid down on the sea floor, have been raised in some instances miles above their former level, and have become part of mountain ranges. Erosion by water and wind has frequently exposed them as ridges and outcrops. During the aeons of time which have passed between the original deposition and the present, the remains of sea animals have been transformed through heat, percolating waters and pressure into massive rock,

[1] Clarke & Turner. J. Soc. Glass Techn. III, 1919, 260-266.
[2] Clarke. Data of Geochemistry, 554.

A DOLOMITIC LIMESTONE QUARRY

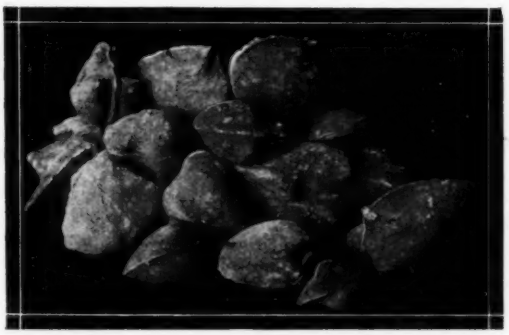
calcite or marble, or in earthy marl, a mixture of limestone and clay. Chalk, which under the microscope still shows traces of its organic origin has undergone only slight changes since its formation.

Quarrying Limestone

Usually the first operations necessary in the quarrying of limestone is the removal of the top soil or earthy overburden, in order to obtain a clean product. When the limestone rock is uncovered it is broken up by drilling and the use of explosives. The limestone is then further reduced in size and transported in the shape of large lumps to be crushed and ground to varying degrees of fineness. For window and plate glass buckwheat size is generally preferred. For fine glassware limestone is used in the form of a coarse powder.

Distribution of Limestones in the United States

Limestone of suitable composition for glass manufacturing are so widely distributed that no particular regions or states require special mention. In the New England States crystalline limestones occur. In the Appalachian States, from New York to Alabama there are many limestones of high purity in the Palaeozoic deposits, notably the Trenton,



FOSSILS OF CANADENSIS MEGALOMUS FOUND IN LIMESTONE

Lower Helderberg and the Carboniferous strata. Suitable limestones are also available in the Pacific Coast States.

Purity of Limestone

When a limestone of unknown composition is considered for use in glass manufacturing it is of the greatest importance to obtain an accurate chemical analysis giving the percentages of calcium carbonate, magnesium carbonate, silica, alumina, organic matter and above all else the amount of iron oxide present. Limestones high in alumina nearly always contain small amounts of alkalies and titanium oxide. Limestones are rarely free from phosphoric acid, which may vary from a trace to one half of one per cent.

In judging the quality of a limestone the first thing to be considered is the kind of glassware which it is desired to produce. Brown and green bottle glass does not require a limestone low in iron. For window and plate glass some limestones can be used which would be entirely out of the question for high grade table glassware. The purity of sand, soda ash and salt cake to be used in connection with the limestone should also be considered. If these are very low in iron it may be quite possible to use a limestone which would have to be rejected otherwise.[3] The essential thing is the *total* amount of iron which will occur in the glass due to all of the raw materials used. If this quantity is too much, at least one of the materials must be replaced by one of greater purity.

Dolomitic Limestone

Practically every variety of limestone contains at least some magnesia. When notable amounts of magnesium carbonate are present the term "dolomite" is used. Properly, the word should be restricted to the definite double carbonate of lime and magnesia in the molecular ratio of 1: 1. Ordinarily magnesian limestone is a mixture of calcite and dolomite, in which the ratio of lime to magnesia is greater than 1: 1. Many dolomitic limestones contain too much iron to render them available for glass manufacturing.

The use of magnesian limestone was formerly looked upon with disapproval. Recent research however tends to show that far from being detrimental, the presence of magnesia in glass gives it some highly desirable properties. Magnesia renders glass fusible at a lower temperature, extends the working range of glass, gives it greater mechanical strength, better thermal endurance and a finer brilliancy. Magnesia lowers the annealing temperature of glass. It is especially valuable in the production of electric light bulbs, thermos-bottles, lamp chimneys, gauge glasses and all glassware exposed to sudden changes in temperature. Dolomitic limestone is the simplest agency of introducing magnesia in the batch.

Glass containing lime and magnesia in about equal proportions has a lower coefficient of expansion than glass of the same composition containing only lime. For this reason such glass is used for making electric light bulbs since its coefficient of expansion can be made to equal that of the leading-in wires.

Manufacture of Burnt and Hydrated Lime

Burnt lime is made from limestone by heating the latter to about 900°C in a kiln calcium carbonate begins to

[3] For specifications of limestone see THIS JOURNAL, Vol. 3 (1922), 54.

Illustrations by courtesy of the Ohio Hydrate & Supply Co., Woodville, O.

decompose below a red heat into calcium oxide and carbon dioxide but the decomposition is not complete until a bright red heat is reached. The equation is as follows:

$$\underset{\text{limestone}}{CaCO_3} = \underset{\substack{\text{burnt}\\\text{lime}}}{CaO} + \underset{\substack{\text{carbon}\\\text{dioxide}}}{CO_2}$$

100 parts of limestone yield 56 parts of burnt lime, and 44 parts of carbon dioxide which escapes as a gas. Therefore, in order to introduce 1 part of lime, it is necessary to weigh out 1.78 parts of limestone.

It is essential that the gases escape freely from the kiln in which the limestone is burnt. The draught is usually sufficient to remove them as they are formed. The escape may be accelerated by blowing air into the kiln during burning.

The best fuel for lime burning is wood, since it gives a long flame of moderate heat intensity. Coal, coke, oil, natural and producer gas are used to a large extent. The calcination of one kilogram of limestone requires 425 calories. Taking the thermal value of carbon as 8180 calories, it appears that 100 kilograms of limestone require $\frac{100 \times 425}{8080} = 52.5$ kilograms of carbon as fuel, producing 56 kilograms of burnt lime. This does not include the fuel required to heat the limestone to the dissociation-temperature neither does it account for radiation losses and those due to conduction of heat.

Should the temperature in the kiln rise above 1200°C there is danger of overheating the lime, which then becomes "dead burnt" and loses its property to absorb moisture to form hydrated lime.

Slaked lime, or hydrated lime is made by adding just enough water to burnt lime to complete the reaction. It requires great care to produce the proper kind of hydrated lime. The proportions of water to burnt lime should be accurately measured. The best results are obtained by using mechanical hydrators, consisting of a revolving pan with ploughs to mix the charge of lime and water.

The following reaction takes place, with the evolution of considerable quantities of heat:

$$\underset{\substack{\text{burnt}\\\text{lime}}}{CaO} + \underset{\text{water}}{H_2O} = \underset{\substack{\text{hydrated}\\\text{lime}}}{Ca(OH)_2}$$

Limestone, Burnt Lime or Hydrated Lime?

There is still considerable difference of opinion among experienced glass makers as to which form of lime is the best suited for various purposes. Each form has certain advantages. A careful comparison of the advantages and disadvantages leads to the conclusion that limestone or marble is the most desirable form for the introduction of lime for plate and window glass.

The use of hydrated lime is very restricted. The only advantage of using this material is the fact that it does not cause an irritating dust, and is therefore easy to handle. The material is expensive. It is not stable in storage as it tends to combine with the carbon dioxide present in the air. This necessitates frequent analyses, to determine the percentage of calcium oxide present.

The question therefore narrows down to a choice between carbonate of lime and burnt lime. In the past it was difficult to obtain limestone in finely divided form. However it was easy to get powdered burnt lime, and for this reason burnt lime was used a great deal in all sorts of glass. The burning of the limestone causes destruction of any organic matter present, which tends to give a purer product. This advantage, however, is of no value in the manufacture of glasses in which salt cake is used, since salt cake requires carbon in some form for reduction.

A serious disadvantage is the tendency of burnt lime to absorb moisture and carbon dioxide in storage, which renders its composition uncertain. The following tests indicate the deterioration of burnt lime in keeping.[4]

(1) Powdered lime was placed in the floor of a dry shed in such a way as to expose a large surface. Every day during sixty-four days it was turned over with a spade and re-spread to cover the same floor space. At the end of this period the percentage of free lime had decreased from 69.1 to 39.5 per cent.

(2) Powdered lime was dumped in a heap outside and exposed to the weather for four months without being touched. Analysis showed the following percentages of free lime:

	Per Cent
At commencement of test	69.1
After four months exposure:	
Crust of heap	0.0
Interior of heap	66.9
Average of mixed crust and interior....	60.8

(3) A sample of lump lime was dumped outside and exposed to the weather. In four months the free lime decreased from 81.2 per cent to 33.8 per cent.

It appears therefore that in order to store burnt lime to the best advantage it should be kept in a heap, in finely divided form, and without stirring.

The property of burnt lime to absorb carbon dioxide and water causes a decrease in the amount of lime in the glass, unless the batch proportions are changed to make up for the difference in composition. In glasses which are already low in lime, failure to make such a correction may have serious consequences. It may result in the production of a glass of insufficient durability.

A disadvantage of the use of burnt lime is the dust which makes the material difficult and disagreeable to handle.

Hodkin and Turner[5] found that a batch composed of soda ash and burnt lime melts in all cases faster than any other combination, while at corresponding temperatures it is also the most fluid. Salt cake—limestone mixtures, however were found to melt quicker than salt cake—burnt lime.

Burnt lime is used extensively in the production of blown and pressed tank ware and of flint glass bottles. Green glass bottles and green glass fruit jars however are usually made with limestone, although some manufacturers prefer burnt lime. Whether limestone or burnt lime is best remains one of the unsolved problems of glass manufacturing.

[4] Woodhead, *Analyst*, 43 (1918), 161.
[5] THIS JOURNAL, Vol. 2, No. 10 (October, 1921), 237-239.

Limestone is stable and can be stored indefinitely without change except in its moisture content which may vary somewhat according to the humidity conditions of the atmosphere in the storage place. The dissociation of limestone during the melting process in calcium oxide and gaseous carbon dioxide exercises a stirring action which makes for homogeneity of the glass.

It is of course true that limestone requires considerable heat for its dissociation, and that more fuel is required to produce glass from limestone than from burnt lime. But the higher price of burnt lime more than offsets the saving in fuel effected by using the latter. The saving of fuel can never be seriously advanced as a point in favor of the use of burnt lime. Real advantages are the facts that the use of burnt lime appears to increase the melting capacity of tanks and that its freedom from organic matter aids in producing higher grade ware, provided the lime is free from iron, titanium and other objectionable elements. Whether the advantages of burnt lime overbalance its drawbacks remains an open question. Although the general opinion appears to become more favorable towards the use of limestone, there is no tendency in this country to abandon the use of burnt lime in those branches of the industry where its use has become firmly established. In Europe expert opinion appears to favor the use of carbonate of lime.[6]

Above. — A battery of kilns.

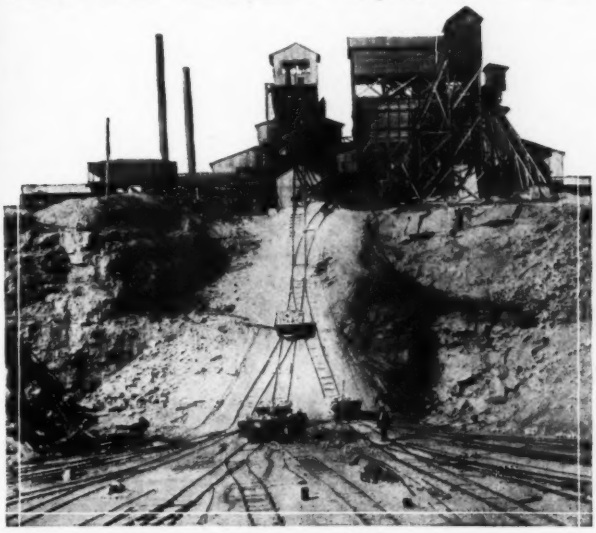
At Left.—Hydrator where lime is mechanically slaked.

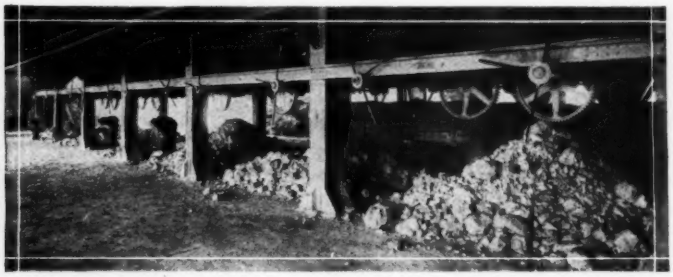
On account of the great importance of this question the National Lime Association has made an investigation of all factors involved. The conclusions arrived at follow:

National Lime Association on Burnt Lime vs. Limestone in Glass Manufacture

ADVANTAGES OF BURNT LIME.

1. UNIFORMITY. The fact that burnt lime is produced under well-controlled conditions and that great care is used in selecting both the stone which enters the kiln and the finished lime results in the production of a much more uniform product than is obtained in the ordinary run of limestone. It is the general consensus of opinion that uniformity in the materials used in glass manufacture is of just as much, if not of greater, importance than the actual composition of the material. That is to say the glass maker does not wish to have to change his batch every time a new shipment of raw materials is received.





Above.—A modern lime manufacturing plant.

At left. — Burnt lime on cooling floor below kilns.

2. PURITY. Although quicklime should theoretically have a slightly higher proportion of impurities than would the corresponding limestone from which it is made, yet in practice this is not always the case. The fact is that very careful selection of the limestone which enters the kiln and the careful selection of the finished lime as it comes from the kiln tends rather to reduce the proportion of impurities. Furthermore the lime having been burnt at a high temperature it will not contain any appreciable quantities of organic matter as do ordinary limestones in their raw state.

3. EASE OF CONTROL OF GLASS BATCHES AND QUALITY

[6] Zschimmer. Theorie der Glasschmelzkunst, II, 77; Keppeler in Dralle, Glasfabrikation, I, 168.

[7] Details of these energy and fuel relationships are discussed in THIS JOURNAL, Vol. 3, No. 4, (April 1922) 79, 80 and on page 119, (June 1922).

OF GLASS OUTPUT. The above facts clearly show that with a well controlled and pure raw material such as is burnt lime the glass batch can be more easily controlled and the quality of the output can the more easily be kept at a definite high standard.

4. REDUCTION IN QUANTITY OF DECOLORIZER. The purity, uniformity and lack of organic matter in the burnt forms of lime render it unnecessary to use so much of the expensive decolorizer which is ordinarily required in the manufacture of glass from the average limestone.

5. INCREASED CAPACITY OF FURNACES AND INCREASED OUTPUT. Definite data as the result of large scale tests in a number of plants show positively that it is possible with the same installations of glass furnaces or pots to produce 12 per cent more glass when burnt lime is used than if limestone is used. This, of course, reduces costs of all the overhead items.

6. REDUCTION IN FUEL COSTS. There is no question but that the lime kiln is a more efficient apparatus for burning lime than is the ordinary glass pot or furnace. On the basis of theoretical considerations the saving of fuel by the use of burnt lime as against limestone should be approximately 46 per cent. Owing, however, to the very great fuel inefficiency of the ordinary glass pot (efficiency of average glass furnace only approximately 10 per cent) this fuel saving is reduced to only about 4 per cent. However, the increased capacity as indicated above would raise this considerably. In those plants where the efficiency of the glass furnaces are above the average, the fuel savings are increased proportionately.[7]

Another item which must be considered in this connection is the fact that much more complete combustion of the fuel used in heating the pots is obtained when burnt lime is used as against limestone. This is more completely explained below under paragraph 3 under "Disadvantages of Raw Limestone."

Data recently obtained on a large glass plant in Oklahoma where gas is used as fuel at a cost of 15 cents per thousand cubic feet, the gas having a B. t. u. of 1100, shows that it costs this plant over $6 in gas to reduce two tons of stone to lime or in other words it costs $6 in fuel to produce one ton of lime.

7. SHORTER TIME PER MELT. Since it is not required to decompose the limestone and since the reaction of the constituents of the glass batch starts immediately that the proper temperature is reached, less heat energy need be applied and for these reasons the time required for each batch or melt is very materially reduced.

8. GREATER LIFE OF REFRACTORIES. On the basis of the facts stated above, that is, the greater production glass, the shorter time per melt, the smaller amount of heat energy introduced it naturally follows that the refractories used in the manufacture of glass will have a much greater life. This again reduces production costs.

9. NO WHITE FILM OF "BLOOM." It is the general experience that difficulties attending the use of certain raw materials which result in the production of a white film or bloom on the glass, are very materially reduced if not eliminated by the substitution of burnt lime for limestone.

10. Lime can be used for other operations around the glass manufacturing plant, such for example as:

a. Softening water for the power plant.

b. Mixing with plaster of Paris for bedding the glass on the grinding tables.

11. Less freight and usually shorter hauls.

DISADVANTAGES OF RAW LIMESTONE.

1. Nonuniformity and uncertainty of composition. See explanation under 1 above.

2. Increased fuel costs. See No. 6 above.

3. INCOMPLETE COMBUSTION OF FUEL. When the limestone is decomposed in the glass furnace large volumes of carbon dioxide are evolved. Under certain conditions this is very likely to smother the flame and to retard the combustion of the fuel resulting in incomplete and inefficient combustion. This frequently results in an absorption of carbon in the batch resulting in complete destruction of color and of the decolorizer because the reducing action of the carbon and carbon monoxide reduces the manganese decolorizer making the color of the glass much stronger. It is frequently the case, therefore, that the glass which without any manganese decolorizer would possess a light sea-green color assumes more of an olive-green or muddy color.

DISADVANTAGES OF LIME.

1. DIFFICULTY OF STORAGE. It is, of course, true that hydrated lime can be used but the general preference is for quicklime. Quicklime as we know requires somewhat more care in storage than does limestone. It must be protected from the weather and from hydration and carbonation during the period of storage. Any hydration or carbonation during this period of storage, of course, affects its composition in respect to the calcium oxide or calcium oxide and magnesium oxide content. This change, however, does not affect the quality of the glass produced provided allowances are made for the change in composition.

2. It is frequently claimed that the handling of quicklime is a more unpleasant task than handling of limestone.

ADVANTAGE OF LIMESTONE.

1. BOILING ACTION. It is generally claimed that the boiling action in the glass batch which results from the evolution of carbon dioxide from the stone produces a greater homogeneity and a quicker melting of the glass. These facts, however, have not been definitely proved. This advantage might be attributed to the use of hydrated lime.

2. LESS OBJECTIONABLE TO HANDLE.

[In this discussion by the National Lime Association no mention is made of the important fact that burnt lime is considerably higher in price than raw limestone.—EDITOR.]

Borax in Glass

To ascertain the amount of borax needed to provide a given percentage of B_2O_3 in the glass, multiply the desired B_2O_3 content by 2.735. For one ton of glass analyzing 10% of B_2O_3, the quantity of B_2O_3 required in the batch is:

Tons $1/10 \times 2.735 = 5$ cwt. 52¾ lbs. borax.

Make allowance in batch for soda derived from the borax.

The Thermal Efficiency of Glass Melting

A Discussion of Factors Governing Fuel Consumption

By D. J. McSwiney*

(Concluded from the August Issue)

The efficiency of transfer of heat from the flame to the glass can be increased by so constructing the ports as to cause the flame to impinge on the surface of the glass, as here part of the heat transfer takes place by conduction from direct contact instead of by radiation. However, this impingement tends to increase the undesirable effect of unbalanced combustion on the color of flint or amber glass.

Supposing the gas entering the port on the outgoing side has a temperature of 2,500° F. Through radiation from the port, this temperature will drop to about 2,400° F. at the top of the checkers. Allowing a differential of about 100° F. for transfer of heat between brick and gas, this will mean that the maximum temperature of the top checkers will be about 2,300° F. and that the maximum temperature of the incoming gas and air will be about 2,200° F. The maximum preheat of the incoming gas and air is determined entirely in efficient regenerators by the maximum checker temperature, and this in turn is determined by the temperature of the waste gas leaving the furnace. With efficient heating the temperature of the waste gas leaving the furnace is determined by the melting temperature, so that the maximum preheat of the incoming gas is in turn determined by the melting temperature and with efficient regenerators it is independent of the temperature at which the incoming gas and air enter the regenerators and is unaffected by insulation of the regenerators.

If the regenerators are already efficient the effect of insulating them is to store up more heat in them by decreasing the temperature drop from the top to the bottom of the checkers; this tends to increase the temperature of the waste gas leaving the regenerators, but does not affect the degree of preheat of the incoming gas and air, except for a slight decrease in the temperature drop of the top checkers during the preheat period. That is, if no waste heat saving device is used, the only effect of insulating efficient regenerators is to decrease the heat lost by radiation and increase that lost up the stack. If the regenerators are not efficient, the first effect of insulation is to tend to increase their efficiency to the maximum and then to increase the stack temperature. The same results are obtained by increasing the temperature of the gas and air entering the regenerators by insulation of the producer and gas canals or by preheating the air by passage over the crown or by sucking it from around the machines and bridgewall, etc.

PART of the heat lost up the stack is necessary to promote the draft which draws the waste gases out of the furnace and through the regenerators. Unless some system of forced draft be employed, a loss of heat to the amount necessary to maintain the waste gases at about 600° can be considered as unavoidable.

Part of the heat lost up the stack is necessary to promote the draft which draws the waste gases out of the furnace and through the regenerators. As the temperature of the waste gas at the base of the stack diverges from about 600° F., the efficiency of the stack decreases unless an oversize stack is used. So that, unless some system of forced draft be employed, an amount of heat necessary to maintain the waste gases at that temperature can be considered as unavoidable. If the temperature of the waste gases at the base of the stack is higher than 600° F. —as is usually the case—there is lost unnecessarily an amount of heat equal to that which would raise the waste gas from 600° to the temperature they possess.

The amount of heat lost up the stack depends on the volume of the waste gases, on their composition and on their temperature. Any particular combustible material will always require the same amount of air for complete combustion and will always give the same volume of waste gas of the same composition at any particular temperature, whether the combustion takes place in one step, as when coal is burnt under a boiler, or in two steps as when it is changed to producer gas and this gas is then burnt. Any inert gaseous material added to the combustible will increase the stack loss. This is true of the steam added in the producer or used for atomization in an oil burner, especially as the specific heat of steam is relatively high. In the case of steam used in the producer, aside from the necessity of steam to keep the producer temperature within safe limits, the saving in decreased radiation and especially in increased furnace efficiency resulting from its use, greatly overbalances the increased stack loss. The use of steam in an oil burner instead of air is due to the much greater convenience of the former; however, the increased stack and furnace loss resulting from the use of steam in this case should certainly be considered. The presence of inert nitrogen in the air causes a large part of the stack and furnace loss, but this is unavoidable.

Effect of Air Supply on Combustion

As stated above, any quantity of any particular combustible always requires a definite quantity of air for complete combustion; if less than this quantity of air be sup-

* Consulting Chemist.

plied, the combustible will not be completely burnt; if more than this quantity of air be supplied, the combustion will be completely burnt but the excess of air will act as inert diluting material. Efficient combustion takes place only when the amounts of gas and air supplied the furnace are such that complete combustion of the gas takes place without any excess air being present. In the ordinary glass furnace there is no accurate means of so proportioning the amounts of gas and air supplied the furnace as to get efficient balanced combustion; the supply of gas is largely controlled by the producer operation, while that of the air is controlled by the stack draft and the temperature differential between the air and the checker brick. Changes in stack draft are ordinarily made, not to control combustion, but merely to modify the distribution of heat between the melting and working ends of the tank by modifying the pressure within the tank. In no other line of manufacture where the cost of fuel is a very important item is so little attention paid to the attainment of balanced combustion as is the case in glass manufacture, and there is no other factor in the use of fuel which can occasion greater heat loss or which can be as readily controlled.

If the supply of air is insufficient beyond a certain point, it is indicated by a smoky flame or smoky stack exhaust, but the presence of an excess of air cannot be seen by inspection of the flame or the stack gases. Unbalanced combustion acts like poor gas and tends to reduce furnace efficiency by decreasing the maximum temperature attainable and by abstracting a greater amount of heat from the furnace than would be lost through balanced combustion.

If the amount of air used is insufficient for complete combustion, all the fuel value of the gas is not rendered available, because part of the gas remains unburnt, and consequently the maximum flame temperature is not attained and fewer heat units are available for transfer to the glass and tank. If the amount of air used is greater than that which is necessary for complete combustion all the gas is completely burned so that all the available heat units are set free, but the combustion is diluted by the excess air and the heat units cannot go as far in raising the temperature of the burning gas because of this dilution; this serves to decrease the maximum flame temperature, and thus to decrease the efficiency of transfer of heat to the glass. By increasing the amount of waste gas leaving the furnace at melting temperatures it takes away from the furnace heat which would otherwise go to the glass and walls, and in fact acts like increased radiation from the furnace; and by increasing the volume of waste gas, it increases the stack loss. A similar effect is produced by the steam used for oil atomization.

In practice, the heat loss from unbalanced combustion is much greater from the presence of excess air than it is from incomplete combustion. However, as incomplete combustion is likely to have an undesirable effect on glass conditions, it is better to err slightly on the side of excess than of insufficient air. By maintaining a check on the composition of the waste gases, the amount of excess air used should be controlled; the oxygen content due to excess air should not exceed 1 per cent to 1½ per cent. It should be remembered that one per cent of excess oxygen means about five per cent excess air. An analytical recording instrument for glass furnaces would be very desirable; in any case, the waste gas composition should be often checked by the analysis of separate samples taken at different periods of operation. With a large air excess, the regenerators, even if they are normally efficient, are unable to fully preheat the increased volume of incoming gases which result in still further decrease in furnace efficiency. A large air excess is usually caused by too high a stack draft; the low furnace pressure resulting from the high stack draft may cause cold air to be drawn in through the doghouse and other furnace openings, thus increasing the chilling effect on the furnace.

Effect of Insulation

The greatest heat saving theoretically possible is that which would result from the efficient insulation of the crown, walls, ports and bottom of the tank, especially of the crown. As previously stated, the insulation of the regenerators will effect little or no direct saving in heat unless the regenerators are not primarily efficient.

Over fifty per cent of the heat from the fuel burned is ordinarily lost by radiation from the tank, and of this fifty per cent the loss from the crown alone is almost half. The rate of heat loss depends largely on the difference between the outer temperature of the block or brick and that of the atmosphere, on the smoothness of the brick or block and on the ease of air motion around them. Although the heat loss is commonly termed radiation, the greatest loss results through the formation of convection currents.

In a tank operated at about 2,500° F. and of the usual construction, the temperature of the surface of the crown over the melter is between 550° and 650° F., that of the ports is about 450° F., of the top of the regenerators is about 250°, of the walls between the ports about 325°, and of the bottom about 200° F. The question is whether insulation can be applied to the crown and walls without fear of premature failure, and to what degree and at what points it can be safely applied.

The entire working end of the tank is probably at a temperature sufficiently low to allow insulation, with the possible exception of the block along the metal line especially near the troughs, and the bridge wall near the throat. However, it is probable that insulation of the refiner without corresponding insulation of the melter will, in the case of many tanks, interfere with the heat distribution between the melter and refiner. The refiner or working end of the tank serves for the most part as an intermediate station between the melting end of the tank and the working points, where the hot glass from the melter is gradually cooled to a temperature nearer that at which it is to be worked. In most cases, it is sought to have an average temperature of the working end about 200° F. lower than that of the melting end; but in many cases this difference is difficult to maintain unless a high stack draft is carried with resulting excess of air in the combustion, and to lessen the spill-over of heat from the melter which results in many tanks when balanced combustion is maintained, the working end is often made much larger than is necessary or baffle walls are built up on the bridge wall. Insulation of the refiner without corresponding insulating of the melter would tend to increase the difficulty of maintaining a lower refiner temperature in these cases.

If, on insulation of a tank, the fuel supplied the tank is correspondingly decreased so as to maintain the same temperature held before insulation, the temperature of the inner surface of the block will not be increased by the insulation, as the temperature of this inner face is dependent on the tank temperature. The effect of insulation will be to decrease the rate of temperature drop through the brick or block; that is, without insulation the temperature of a very thin layer of inner block surface will be approximately that of the tank, and the temperature of the layers outside this surface layer rapidly decrease until the temperature of the outer surface is reached. With insulation, the layer on the inside of the block which is at approximately the same temperature as the tank will be much thicker than in the previous case and the drop in temperature of the succeeding layers will be slower than in the first case; the outer temperature of the brick or block will be higher with insulation than without it while the outer temperature of the insulation will be very much lower than that of the uninsulated block.

TO many manufacturers coal is coal, and the only thing that interests them is its price. Coal is bought only for its heating value which may vary as much as thirty per cent. Coal should be bought on some form of specification, especially as regards the fuel value, and its content of moisture, ash and sulphur.

The degree to which molten glass will penetrate a block and the rate of solution of the block by the glass is largely determined by this rate of drop in temperature through the block. Accordingly, it is doubtful if the block in the walls of the tank, especially the side walls near the middle of the melter, could be safely insulated at a distance near enough to the metal line to cause any considerable increase in glass penetration at this point, as such insulation would probably cause premature block failure in many cases with our present refractories. It is probable that the ports could be safely insulated to some extent and also the bottom and the walls at a safe distance above and below the metal line.

The greatest saving through insulation would be effected by insulation of the crown, as this is the part of the tank where the outside temperature is highest despite the fact that opportunities for heat loss at this point are greatest due to lack of interference with convection currents developing on the surface. The crown is usually formed of eight to twelve inch brick composed of silica bound together by a small amount of calcium silicate. In the fresh brick the silica is present partly as quartz, but largely as tridymite and crystobalite. On heating at furnace temperature, the quartz in the inner face of the brick is gradually completely converted with resulting increase in the volume and refractoriness at this point. The degree of conversion of the quartz at varying depths in the brick depends on the rate of temperature drop through the brick; as this rate of temperature drop is decreased through insulation, the depth of complete conversion is increased.

The melting point of the silica brick is about 3,000° F. Under normal melting conditions only the face of the brick ever reaches this temperature and then only when the flame impinges on it, so that only a very thin film of molten brick ever forms on the surface because of the rapid temperature drop below the surface. This film is normally thin enough to counteract the action of gravity, but if the rate of temperature drop through the brick be decreased through insulation the thickness of the molten film may be so increased that it is pulled from the surface by gravity, and corrosion, to a serious degree, result.

Silica brick varies in quality as clay blocks do though probably not to so great an extent. The corrosion of the brick is increased by the absorption of fluxing materials from the dusting of the batch, by the spitting of the gas evolution from the melting batch, and the volatilization of alkalies from the glass. As the brick at the back end of the furnace where the batch is filled in and most of the melting takes place does not show much more fluxing action than that near the bridgewall where no batch particles could readily penetrate, it is probable that the crown corrosion influence attributed to dusting is usually exaggerated. In the case of many tanks the crowns of which have been in service for several years, the inner face of the crown often shows little or no evidence of fluxing action such as should result from attack by batch materials, even above the filling end of the tank.

In order to travel from the glass level to the crown such particles would have to be very small and being very small they could not readily pass through the thick rapid current of burning gas. Decrease in the velocity of the flame resulting from insulation might allow more of the particles thrown up by the effervescing batch to reach the crown. In a burning gas flame, the direction of whose flow is parallel to the surface of the melt, the flame which sweeps back over the crown comes largely from the upper surface of the stream and consequently should have less material from the glass than the flame on the lower surface.

The crown often lasts through several renewals of the block which compose the tank and during this period it accumulates a considerable layer of dust on its outer surface which must exercise some insulating influence. In view of this and of the fact that silica brick in blast furnaces are subjected to higher temperatures and more drastic conditions than the brick in glass furnaces it would appear that, as far as refractoriness is concerned, some insulation of the crown could be safely practiced.

The expansion which the brick in the crown undergoes when the furnace is warmed in is of two kinds; a temporary expansion due to the rise in temperature and which is lost when the brick cools again, and a permanent expansion resulting in the slow change in the quartz in the brick to tridymite and crystobalite. As the inner face of the brick is heated much more than the outer, the action of expansion of the brick decreasing from the inside to the outside is to change the form of a brick from a rectangular block to a truncated pyramid, the base of which is the inner surface of

the brick. This tends to throw the strain in the crown on the inner layers of the brick. The resistance to compression of silica brick decreases near glass melting temperatures and with insulation the inner surfaces of the brick may not be able to stand the strains and the crown may collapse.

As mentioned above, the only way in which any considerable heat saving can be effected directly through insulation is by insulation of the melting chamber, and that insulation of the regenerators and canals, while tending to maintain the regenerators at their maximum efficiency, has the main effect of merely increasing the temperature of the waste gases leaving the regenerators; the same is true of any change in operation which tends to increase the temperature of the gases entering the regenerators.

Saving of heat in these cases where the waste gas temperature is increased can be effected indirectly by the use of waste heat devices. The use of waste heat boilers is general in the steel industry and could be applied to glass manufacture although to a lesser extent. The temperature of waste gases from a blast furnace is higher than that from a regenerative glass furnace and the volume of gas is very much larger, and as waste heat boilers are rather expensive their installation would pay only in the case of very large furnaces or where two or more furnaces could conveniently be connected with the same boiler. Steam generated by the boiler could then be used to generate power, to operate blowers, for oil atomization, etc. Waste heat boilers are not efficient unless the waste gas temperature is at least 1,000° F. With a battery of gas producers, if the gas is being cleaned before being used, it could first be passed through a waste heat boiler, although it would probably be often necessary to blow the soot out of the boiler; if the gas is not being cleaned, and the gas canals are insulated the sensible heat of the producer gas will be effective in a waste heat boiler used on the waste gases.

Waste heat can be used to dry the batch materials before filling into the tank; it is doubtful if it could be used for fritting the batch materials as this would require a temperature higher than 1,500° F. and gas at that temperature could not be conveniently obtained or handled; some heat can be saved by preheating the batch by waste heat but this introduces difficulties of construction and operation.

The heat saving methods which are most readily available are those which aim at increasing the operating efficiency, the combustion efficiency, and efficiency of transfer of heat to the glass, by increasing the maximum allowable pull, by improving producer operation, and by maintenance of balanced combustion. The introduction of insulation at any point, while admitting the greatest possibility of heat saving should be made gradually, until the effect on the life of the tank of different degrees of insulation at various points has been first determined.

American vs. European Patents

By an English Patent Attorney

It is probably well known to all readers of this journal that the American (and Canadian) patent systems are in many important respects dissimilar to those of Great Britain and most European countries, but in the writer's experience, judging from a large number of European patent applications emanating from American inventors, there is very wide failure to appreciate how important and far-reaching such differences are. As a result of this, it is undoubted that the service obtained by American inventors from European patent systems is vastly inferior in efficiency to that obtained from the American system by European inventors, not because equal or even greater possibilities are not to be had, but because the American inventor so frequently fails to exercise sufficient alertness to make use of them. It is the purpose of the present article, therefore, to bring to notice one or two important and quite simple points which may enable such readers of this journal as are patentees to avoid in future what has probably been an unwarrantably high "percentage risk" attaching to a large number of their patents in the past.

A fundamental and far-reaching difference between the two systems is to be met on the very threshold of the inventor's career. In the United States of America, an inventor is entitled to publish, use or market his invention for two years prior to filing his patent application to cover it, and in the case of inventors in conflict, the rights ultimately belong to the inventor who first made the invention, and not necessarily to him who first filed a patent application in the U. S. Office. To carry this principle into effect, a fairly elaborate machinery of interference proceedings has been set up, whereby the Patent Office is enabled to decide between conflicting inventors as to which first actually conceived the invention and is thus entitled to the rights.

In Europe this is not so, but on the contrary the publication of a description, or the public use or sale of a new invention prior to the lodging of a patent specification containing a full description of it, is usually fatal to the successful acquisition of subsequent patent rights. This rule is generally based on the theory that any person becoming acquainted by any legitimate means with the details of an ingenious device is naturally entitled to construct and use the device himself, unless there already exists a prescriptive right which debars him from so doing. If, however, no such right exists, that is to say, if at the moment he becomes acquainted with the details of the device, there is no bar to his using it there and then, the right he has thus acquired can never be taken away from him by the later act or deed of any person whatsoever.

Thus, if A makes an invention and shows it, even in confidence, to B, and B allows it, in bad faith or inadvertently, to become known to C, then C is thereby entitled to use it and nothing that A can do at a later time can deprive him of the right thus acquired.

In European countries, therefore, a patent application

* American Chamber of Commerce in London, *Anglo-American Trade*.

must be filed before the invention is disclosed in a public manner, and the proviso is made most severe since as a rule the patent application is required to be filed before a description of the invention has appeared in print *anywhere in the world,* on the ground that knowledge is universal and when once unguarded publication has occurred the whole realm is entitled to make use of the ordinary channels of communication to obtain the full benefit of any knowledge anywhere.

As a corollary to this position, it is also pretty firmly established in Europe that as between conflicting inventors, the one who files the first patent application in any country is entitled to the rights in that country.

Now consider what frequently occurs when an American inventor seeks European patent rights.

Having made his invention, he first tries it out in the United States, takes time to prove its success and obtain financial assistance, and at the end of two years applies for American rights by filing an application at the U. S. Patent Office. The rules of that office allow twelve months within which an official requirement may be complied with, and a patent application very frequently may be pending before the U. S. Office for three of four years before the final state of the claims is settled. In the meantime the inventor has probably turned his thoughts to Europe ever since the invention first showed sufficient promise, but he thinks he may as well wait till the American claims are accepted before deciding on his European patents in order that he may be fully advised as to the state of the art, and may file a European specification based on the accepted American claims. He then files his European patents, and in later times seeks to put them into operation only to find that several of the models which he made during the five years before the European patents were filed have found their way over to Europe, and are naturally in the hands of those who are most interested in upsetting his patent rights, that is to say, his principal competitors in the field to which his invention relates. In these circumstances, he is utterly unable to exercise any of the patents against the people most naturally prone to commit infringement and to get away from the cover he thought he had secured for himself.

In a typical case of this distressing character, not only had the goods come over to the principal European capitals, but the inventor, during the three years that his principal patent was before the American Patent Office, had filed a small patent application for an improvement on his main invention, which went through the U. S. Office with little delay, so that the specification was duly printed long be fore his main patent claims had been settled. In accordance with the usual practice, copies of the printed specification of the improvement patent were immediately circulated by the American Patent Office to all patent offices of the European countries, with the result that not only were the commercial models able to be used against the subsequent European patents for the main principle, but an actual document was on the files of the European Patent Offices which gave a full disclosure of the principle, and was filed, indexed and made readily accessible for the most superficial investigator to unearth with a minimum of trouble. Thus the inventor's main patents were rendered quite innocuous, and he only discovered this fact when he was on the point of instigating legal proceedings in Europe for infringements.

Reference should here be made to the provisions of the International Convention, whereby the United States and most European countries have agreed that where a patent application has been lodged in one of those countries, a later patent application by the same inventor or his assignee for the same invention in any other of those countries may be given priority dating back to the date of the home application; but there is a limiting term of twelve months to the period within which this priority can extend, the twelve months running from the date of *filing* the first application. The result of this is that when once an American patent application has been filed, provided that the foreign application is made within twelve months of such filing, nothing that the inventor may do by way of publication *in the meantime* will invalidate the foreign application; but the benefit is strictly limited, since the cover does not apply to any act of publication that may have occurred *prior* to filing the United States application, and only extends for twelve months after the application has been filed.

The writer has been surprised to discover how little is known of this provision amongst American inventors, or alternatively, how largely the erroneous view is held that the benefit of priority can be had for twelve months after *issue* of the American patent and it is the failure to realize the importance of these two facts, namely, that normally there must be no publication of the invention prior to filing a European patent application, and that the benefits of priority only extend for twelve months after the *filing* of the American application, that in the writer's view so frequently stultifies the service obtainable by the American inventor from the European patent systems as compared with that obtained by his European rival from the American patent system.

It should be noted that the rule whereby prior publication of the invention anywhere in the world invalidates a subsequent patent does not apply in the United Kingdom, where prior publication, to be thus effective, must have occurred within the realm. Nevertheless, it is not safe to rely on keeping printed matter cut of the country since practically all the technical journals, proceedings of learned societies and copies of most advertising literature published in the U. S. A. find their way over here and are naturally perused by the people interested in the relevant art, *i. e.,* by those who will be most interested in defeating a later patent if such is applied for.

To sum up, we would advise any American inventor who remotely thinks, on making his invention, of its possible introduction into Europe to take the greatest care to observe the two following rules:—

(1) Keep any models or commercial embodiments out of Europe, and a description of the invention out of print, before filing his U. S. application, and

(2) File his European applications within twelve months of filing his U. S. application, claiming benefit of priority of the International Convention.

The Glass Industry

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ADVERTISING RATES SENT ON REQUEST

Vol. 6. SEPTEMBER, 1925 No. 9

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The Passing of Secrecy

From year to year it is becoming increasingly evident that in the glass industry the era of secretiveness is passing and that present day manufacturers are inclined to relegate the traditional secrecy of their craft to ancient history. Here and there are still found glass men who believe that they are at the mercy of their batch mixer, and who have been bamboozled into thinking that the mysterious book of batch formulas, kept under lock and key by the owner, contains secrets essential to the success of their enterprise.

The race of batch mixers who from ignorance or on purpose add substances to their batches that are of absolutely no value to the product is by no means extinct. There still remain some who try to mystify their employers and endeavor to make their skill look indispensable.

Every industry of ancient origin has gone through this stage. Metallurgy, as old, and probably older than the art of glass making, was at one time a maze of recipes. Through the sifting of the real from the fancied, the essential from the futile, through the labors of thousands of workers the underlying principles of the old art of making metals have been recognized, until modern metallurgy has become almost an exact science. To the willingness to communicate the results of experience and research, to technical and scientific societies and to the technical press belongs much of the credit for the wonderful development of an industry which can now meet practically every new demand as it appears.

The glass industry is rapidly approaching an equal state of development. Through the contributions of hundreds of workers, in the factory, the shop, the laboratory, wherever glass is made, the material is being gathered which forms the new glass knowledge.

Technical men are well aware of the fact that a free exchange of information and a general spreading of knowledge of glass factory operation stimulates development of additional improvements. But in the glass industry as in many other lines of manufacturing the chief executives frequently are not technically trained men. In many instances they have risen to their positions through the commercial section of their organization. Being insufficiently informed about the technical side of their business they become imbued with the belief that the success of their enterprise would be jeopardized if any one should learn about their methods of manufacture. This causes them to prohibit their technical men from discussing industrial processes at meetings or in technical journals. Yet often these same men are anxious to obtain every scrap of supposedly valuable information, without giving anything in return.

In contrast with this state of mind, fortunately the great majority of glassmakers have learned that the development of their industry would be retarded unless there is a free interchange of ideas. They favor publication of improved methods of manufacture in the technical press. They encourage technical men in their employ to discuss operating details with a freedom unheard of only a few years ago. They donate generously towards the foundation of technical schools for the training of specialists. They endow re-

search institutions having the object of attacking fundamental problems with which the whole industry is vitally concerned.

Evidence of this new spirit is obvious to any one reading progressive technical journals and who attends meetings of technical societies. No one expects manufacturers to divulge their own data, their costs and the details of their methods. But under the protection of the patent laws nothing but good can result from an enlightened attitude towards the question of trade secrets.

Technical Consultation Service

QUESTION 75. METHOD FOR DETERMINING ARSENIC IN GLASS.—Please outline the most practical method for the analysis of Arsenic in glasses.

ANSWER:—The total arsenic in glass may be determined by fusing one gram of the sample with a mixture of 3 grams of sodium carbonate and 1 gram of sodium nitrate in a platinum crucible. The fused mass after cooling is treated with sulphuric acid 1:1, the solution is heated to fumes, diluted with water and the silica filtered off. Hydrochloric acid should not be used since this would result in loss of arsenic during evaporation.

The silica is ignited in a platinum crucible and is heated with hydrofluoric and sulphuric acids to effect volatilization. The residue is fused with a little soda and added to the filtrate from the silica. This solution, containing all of the arsenic present in the glass, is gassed with hydrogen sulphide, which precipitates the arsenic as sulphide.

The arsenic sulphide is filtered off and is dissolved in ammonia. Hydrogen peroxide is added in some excess and the solution brought to a boil. Magnesia mixture is then added and the arsenic finally weighed as magnesium pyroarsenate.

A more accurate procedure is to reduce the arsenic acid with hydroiodic acid to arsenious acid and titrate the latter with standard iodine solution.

As requested, we have given only an outline of the procedure. However, if a description of any details is desired, we shall be very pleased to advise you further.—J. B. K.

QUESTION 76.—ETCHING SOLUTION AND PASTE.—Please supply us with a formula for preparing an etching solution for the outside of necks of reflectors.

It would be preferable if this preparation could be made in a paste form so that it would not run when applied to the glass. We would appreciate too if you could advise a method for applying this material in a manner similar to painting on with a brush.

ANSWER:—The following method can be used:

A thin paste is made of powdered fluorspar and dilute sulphuric acid. To prepare the sulphuric acid, pour one part of concentrated sulphuric acid into four parts of cold water—*not the water into the acid.* Allow to cool and mix with the powdered fluorspar in a lead tray, in quantities sufficient to make a paste which will not run. Apply paste to glass and allow the paste to dry at about 50 deg. Centigrade (122 deg. Fahr).

The paste can be put on the glass with a goose quill or with a paint brush. The hairs are not attacked by the paste. It is advisable, however, to surround the top of the brush with tin or lead foil, to prevent the hair from falling out. When the work is finished the brush should be washed with water, dilute ammonia and again with water.

The glass should be clean and free from grease.

If a liquid etching fluid is preferred make up the following solution in a lead vessel.

500 parts of distilled water.
500 parts ammonium fluoride.
50 parts ammonium sulphate.
100 parts sulphuric acid.

This mixture is heated gently until the solution is clear. The solution should give a fine etch in 5 minutes. If this is not the case add 10 parts hydrofluoric acid to the mixture.

It should be kept in mind that these etching solutions attack glass violently. They must therefore be kept in rubber or lead bottles. Hydrofluoric acid fumes are dangerous and should not be breathed. The solution should not be allowed to come in contact with clothes or with the skin. They may cause painful burns which are slow to heal.—J. B. K.

QUESTION 77.—BATCH FOR GLASS.—We are having considerable difficulty with our glass and desire to ask your opinion regarding the batch which we are using. The composition is as follows:

Sand	782 lbs.
Soda ash	224 lbs.
Potash	228 lbs.
Limespar	75 lbs.
Nitrate of Soda	35 lbs.
Bone ash	10 lbs.
Borax	10 lbs.
Uranium oxide	5-7 lbs. (according to color)

ANSWER:—We are of the opinion that the glass which you are manufacturing according to the formula given is much too low in lime, and too soft. The approximate calculated composition is as follows:

Silica	69.5 per cent
Oxides of potash and soda	26.7 per cent
Lime	3.8 per cent

We would suggest that you try the following batch, first testing it out on a small scale:

Sand	700 lbs.
Soda ash	140 lbs.
Pearl ash (97-98 per cent)	125 lbs.
Limespar	200 lbs.
Nitrate of soda	10 lbs.
Bone ash	10 lbs.
Uranium	5-6 lbs.

This formula will give you a better balanced glass. It will, of course, be harder and not as easy to work, but we feel sure that with proper annealing this glass will be satisfactory.

Books

KOLLOIDCHEMIE.—By Richard Zsigmondy. 5th Edition, enlarged and revised. Part I xii + 242 pages; 7 tables; 34 illustrations, 7 x 10 inches. Published by Otto Spamer, Leipzig. Price GMk 11.00, bound GMk 13.50.

The appearance of the fifth edition of Zsigmondy's epoch making book on colloid chemistry will be welcomed by all those who are in any way interested in colloid chemistry and its application in technology, sanitation, physiology and the numerous fields in which this branch of chemistry has opened new avenues of approach to a deeper understanding of nature's secrets.

There is only one achievement in the annals of science with which Zsigmondy's work can be compared, and that is Pasteur's researches on bacteriology. In either case the name of the man is inseparably linked with the science which he has created.

The most striking feature of the present volume is the clarity of presentation of theory and the close adherance to the practical application which is never lost sight of. This is what makes the strong appeal to the technologist and to those engaged in the various branches of applied chemistry. It is certain that the present edition of Zsigmondy's book will add many to the long list of his admirers.

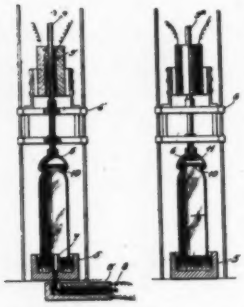
A HISTORY OF OLD ENGLISH GLASS, by Francis Buckley, with a foreword by Bernard Rockham. Published by Ernest Benn, Ltd., 8 Bouverie Street, E. C. 4 London. With about 175 illustrations on 60 half-tone plates. Demy 4to. Art canvas gilt, beveled boards. Price £3 3s. Also an edition de luxe, limited to 100 numbered copies, printed on hand-made paper, bound in pigskin, and with three plates reproduced by hand-printed photogravure. Price £7 7s.

Recent Patents

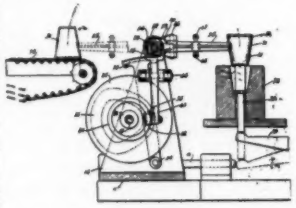
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

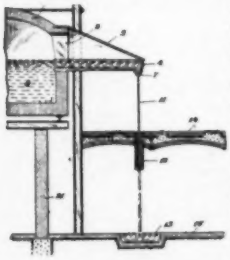
METHOD OF DRAWING GLASS CYLINDERS. 1,546,949. July 21, 1925. Thomas Stenhouse, Washington, Pa., assignor of one-sixth to Alexander L. Duval D'Adrian, Washington, Pa., and one-sixth to Bernard J. Drakenfeld, Jr., New York. Filed 12/2/19. The method of drawing a hollow article from a bath of molten glass, directing diffused currents of heated air into the opposite ends of the article, and increasing the volume of such diffused air currents proportionately to the increasing length of the article to maintain a constantly uniform pressure within the article and prevent pulsations, which occur intermittently during the drawing operation, resulting in the formation of irregular distentions of the cylinder body when air at atmospheric temperature is introduced.



TAKING-OUT DEVICE FOR GLASS-SHAPING MACHINES. 1,547,146. July 21, 1925. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Fairmont Co. Filed 9/3/20. The combination with a glass shaping machine embodying a mold having a body portion and a movable bottom valve, of means for actuating said valve to elevate the ware from said mold, a transfer device provided with a two-part ware holder adapted to be closed about the ware while the ware is supported in an elevated position by said valve, means for opening and closing said holder, and means to move the holder toward and from the mold, said holder being shaped to loosely enclose all sides of the ware without gripping engagement therewith.

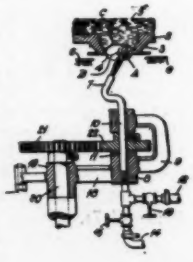


FURNACE. 1,546,544. July 21, 1925. Peter Kucera, Connellsville, Pa., assignor to Capstan Glass Co. Filed 1/27/20. The principal object is to provide a construction adapted for automatic disposal of a stream of glass which is not being used and which it is not desirable to stop. A further object contemplates the arrangement of a floor for supporting machines for glass manufacturing and a trench beneath the floor to be filled with water and so arranged as to receive portions of the glass which may issue from the furnace and which are not being used by the glass machinery.

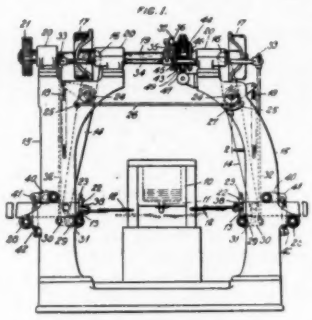


FEEDING MOLTEN GLASS. 1,547,149. July 21, 1925. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Co. Filed 11/18/24. The method of feeding molten glass, that comprises causing the glass to issue from a container through a downwardly opening discharge outlet, periodically severing mold charges from the issuing glass, and in the intervals between said severing operations, retarding the issue of glass from said outlet by directing upon the glass at the said outlet a dynamically-active flame revolving about the vertical axis of said outlet.

The flame may also be employed for reheating the stub of glass remaining after severing operation.

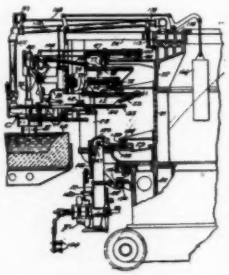


APPARATUS FOR SEPARATING MOLTEN GLASS INTO MOLD CHARGES. 1,547,147. July 21, 1925. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Fairmont Co. Filed 3/25/22. Apparatus for separating molten glass into mold charges including a molten glass container having an outlet through which the glass is discharged, glass severing means, means for moving the severing means in a direction substantially parallel with the direction of discharge of the glass, means for moving the severing means in a direction transverse to the line of discharge, and means for adjusting the relative times of occurrence of these movements during the operation of the apparatus.

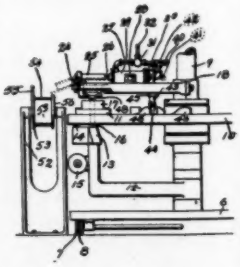


METHOD AND APPARATUS FOR REHEATING GLASS PARISONS. 1,547,148. July 21, 1925. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Co. Filed 11/5/24. The method of reheating a glass parison, that comprises suspending the parison from above and causing a flame to revolve around the parison and in contact therewith.

GLASS-FORMING MACHINE. 1,547,439. July 28, 1925. Michael J. Owens, Toledo, O., assignor to the Owens Bottle Co. Filed 8/11/21. The object is to provide a practical machine in which a number of blanks are simultaneously gathered by each unit. Among the inventor's claims is, in a glass forming machine, the combination of a carriage, means to rotate it continuously about a vertical axis, individual heads or units thereon, a plurality of sectional molds on each head arranged to travel in substantially the same path, means to bring the molds on each head concomitantly into contact with a supply of molten glass, means to then charge the molds by suction, and means to shape the charges into finished articles while traveling in substantially the same circular path concentric with said axis.



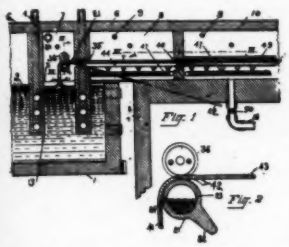
LID TAKE-OFF FOR GLASS-FORMING MACHINES. 1,547,503. July 28, 1925. Harry B. Lawson, Huntington, W. Va., assignor to Schram Glass Manufacturing Co. Filed 9/13/24. A lid take-off for glass forming machines comprising in combination with a glass forming machine having a rotary table provided with a plurality of molds, the means for lifting the finished article of said molds, of a plate pivotally mounted above the path of travel of said molds, a pocket formed on the underneath surface of said plate for receiving the finished article when raised out of the mold, and means for turning said plate with the finished article as lodged in the pocket and discharging the same on to a conveyor.



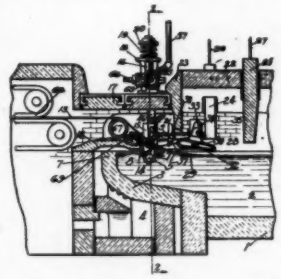
CASED GLASS AND ARTICLES MADE THEREFROM. 1,547,715. July 28, 1925. James R. Baker, Arlington, N. J., assignor to Westinghouse Lamp Co. Filed 10/14/22. This invention relates

to cased or composite glass articles and more particularly to a glass the inner surface of which is resistant to the action of alkali metals, for example, sodium-vapor lamps, and comprises an inner coating of glass, resistant to the action of such vapor and an outer coating or base of a glass, more readily worked and sealed than glass resistant to such action.

DRAWING SHEET GLASS. 1,547,797. July 28, 1925. Robert G. Ewing, Toledo, O., Beatrice A. A. Ewing, executrix of said Robert G. Ewing, deceased, assignor to the Libbey-Owens Sheet Glass Co. Filed 4/6/18. In continuous sheet glass drawing mechanism, a tank for molten glass supply, a convex bending guide for glass from tank, said guide being provided with an internal reservoir and with a vent from said reservoir through the bending portion thereof to the glass contacting guide surface permitting hydrocarbon lubrication of the guide therethrough, and a lehr to which the guide may deliver.

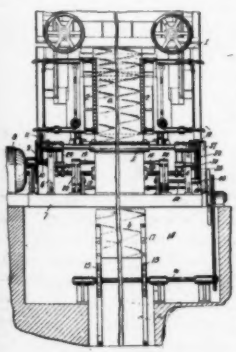


METHOD AND APPARATUS FOR DRAWING SHEET GLASS. 1,547,910. July 28, 1925. Enoch T. Ferngren, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 5/26/22. In general, the invention involves progressively congealing a surface layer of semi-plastic glass on the upper surface of a body of hot molten glass, and then floating or sliding off this surface layer in a substantially horizontal direction and drawing or stretching it into sheet form before it becomes entirely cold and set. A new system of maintaining a circulation in the reservoir of molten glass, to prevent stagnation and devitrification is employed at the end remote from the source of supply.



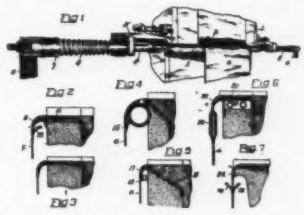
GLASS FURNACE. 1,547,911. July 28, 1925. Enoch T. Ferngren, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 2/19/23. In a sheet glass drawing apparatus, a pot for the molten glass from which the sheet is drawn, in combination with a heating furnace beneath the pot, and a plate of silicon-carbide of substantially the same dimensions as the pot bottom supporting the pot, the plate being mounted at its edges on the furnace structure, and its entire central portion being unsupported and exposed to the heating gases in the furnace.

MANUFACTURE OF SHEET GLASS. 1,548,435. Aug. 4, 1925. William E. Bock, Eagle Point Colony, O., assignor to Erie Glass Co. Filed 11/20/22. The primary object is the provision of means, in connection with sheet glass forming apparatus, for severing a sheet as it advances from the forming source, into successive sections and applying a flattening pressure on each section after a severing of the same from the sheet and while still in a hot pliant condition. Also means before the pressing operation for supporting the severed section in the pressing means and movable from section supporting position to allow the downward passage of the section after the pressing operation. One embodiment of the invention is shown in the illustration.



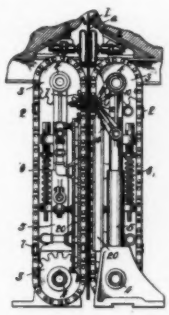
GLASS CUTTER. 1,547,451. July 28, 1925. George T. Scott, Susanville, Cal. Filed 6/23/24. Has a device adapted to go around the finger holding the instrument to prevent it swerving or twisting, also a handle which is adapted to receive new cutting wheels set in a special mounting, and other new features.

MANUFACTURE OF GLASSWARE. 1,548,444. Aug. 4, 1925. Robert M. Corl, Maumee, O., assignor to Erie Glass Co. Filed 10/12/22. In an apparatus for forming sheet glass, means to hold a supply of glass from which the glass sheet is formed, a chromium alloy member in contact with the glass while in a formative condition and while moving from said means, said member terminating in a thin portion having a sharp edge projected in the direction of movement of the glass and from which edge the glass passes.

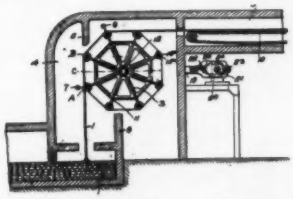


SHEET-GLASS-MAKING APPARATUS. 1,548,445. Aug. 4, 1925. Robert M. Corl, Maumee, O., assignor to Erie Glass Co. Filed 11/2/22. In an apparatus for supporting and severing sheet glass, a pair of opposed rotatable members operable to engage and sever a sheet of glass therebetween as it passes away from a formative point, means operable to successively grip strips across the sheet at longitudinally spaced intervals and to remain in gripping contact therewith throughout a predetermined portion of its movement, the gripping means gripping the sheet before the severing action.

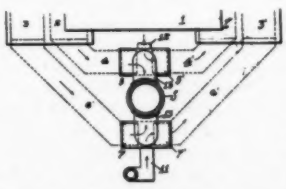
One object of the invention is to remove the severing strain from the clamping bars so the clamping bars will not be bowed or sprung out by the severing action, thereby overcoming that objection.



APPARATUS FOR DRAWING GLASS. 1,548,114. Aug. 4, 1925. Clarence M. Brown, Philadelphia, Pa., assignor to Pittsburgh Plate Glass Co. Filed 8/9/21. The invention contemplates the use of a flat sided reel in drawing sheet glass instead of the usual roller, preferably so constructed that the sheet being drawn will contact with the reel only at the corners. Thus any contact tending to mar the glass in making the turn is reduced to a minimum. After being turned to a horizontal plane the sheet may be conducted through a lehr or passageway where the glass is annealed.



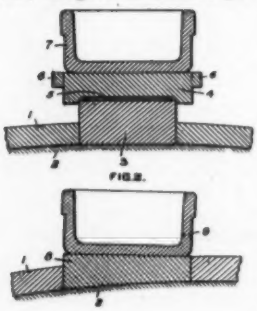
REVERSING APPARATUS FOR HEATING FURNACES. 1,548,419. Aug. 4, 1925. George H. Isley, Worcester, Mass., assignor to Morgan Construction Co. Filed 5/11/23. The combination with an overhead stack connection, a gas or air supply conduit and two underground furnace flues having ground level terminals, of a valve casing whose interior is common to all of said elements, and a swinging valve in said casing, mounted eccentrically, with its larger portion controlling the two flue terminals and its smaller portion controlling the supply conduit, thereby permitting the latter to be disposed above the ground level.



APPARATUS FOR HANDLING GLASS PLATES. 1,548,140. Aug. 4, 1925. Halbert K. Hitchcock, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 12/12/22. Apparatus for carrying a series of glass plates face downward over surfacing tables, comprising an endless chain carrier passing over the tables, carrier plates, means for detachably securing them to the carrier, means for supporting the carrier plates face upward during the attachment thereto of the glass plates, means for cementing the glass in position on the carrier plates, and means for reversing the plates preliminary to their attachment to the carrier.

BULLET-PROOF GLASS. 1,548,490. Aug. 4, 1925. Constantine Shuman and Arthur G. Worrall, Philadelphia, Pa., assignors to Louis J. Kolb, Philadelphia, Pa. Trading as Safetee Glass Co. Filed 11/11/22. Laminated glass comprising a relatively thick sheet of glass combined with a relatively thin sheet of glass secured to the surface of the relatively thick sheet of glass by a suitable binder filling the entire space between the surfaces of the glass sheets, and wherein the relatively thin sheet of glass is bent to conform to the general surface contour of the thick sheet and permanently held in such relation.

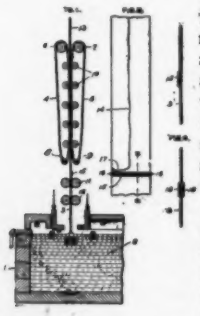
POT SEAT. 1,548,103. Aug. 4, 1925. Lee Showers, Charleroi, Pa., assignor to Pittsburgh Plate Glass Co. Filed 10/6/21. In combination with the arched clay floor of a pot furnace having an opening therein, of a seating block of refractory material, more resistant to wear and strain than the material of the floor itself, set in fixed position in the opening in the floor and having its upper surface flat and continuous and adapted to engage and support substantially the entire bottom area of the pot. Also the seat may readily be replaced in case any unevenness develops or the seat becomes cracked or broken in service.



METHOD OF MAKING GLASS RECEPTACLES. 1,548,611. Aug. 4, 1925. William K. Kearsley, Jr., and Henry A. Waywringer, Schenectady, N. Y., assignors to General Electric Co. Filed 8/18/21. This relates to a method of making glass receptacles provided with a window differing in thickness, composition, or other respects from the main receptacle, and specifically to the manufacture of X-ray tubes consisting of relatively thick lead glass and provided with a window of thinner lime glass.

GLASS-CUTTING PROCESS FOR TRANSLUCENT ARTICLES. 1,550,432 and 1,550,433. Aug. 18, 1925. Harry W. Dych, Philadelphia, Pa. Filed 10/25/24 and 12/12/24. This invention relates to a process for cutting bulbous glass articles which comprises the treating of the exterior surface of said article with a liquid to make the same translucent, then removing a portion of the translucent surface to provide a transparent portion, then cutting the translucent surface by viewing the cutting operations through the transparent portion, then again treating the transparent portion by removing the liquid to make it translucent, then polishing the cutting, and then obliterating the mark of connection between the two translucent portions.

METHOD OF INTERRUPTING LONGITUDINAL CRACKS IN GLASS-SHEET DRAWING. 1,548,104. Aug. 4, 1925. Harry G. Slingluff, Mount Vernon, O., assignor to Pittsburgh Plate Glass Co. Filed 2/26/23. The method of stopping a longitudinal crack in a sheet of glass drawn continuously from a bath of molten glass through a pair of vertical endless belts, which consists in securing to the sheet below the belts a strip of flexible refractory material, such as asbestos, extending transversely of the sheet and secured to it by a pair of wood clamps and permitting such strip to be carried through the belts by the glass sheet, the material contacting with the sheet and affecting its temperature along the line of contact so that the crack is turned laterally to the edge of the sheet.



APPARATUS FOR MAKING SHEET GLASS. 1,549,513. Aug. 11, 1925. Harry G. Slingluff, Mt. Vernon, O., assignor to Pittsburgh Plate Glass Co. Filed 6/5/24. Means for preventing inward movement of the edge of the sheet.

GLASS AND COMPOSITION THEREFOR. 1,545,509. July 14, 1925. Robert J. Montgomery and Murray R. Scott, of Rochester, N. Y., assignors to Bausch & Lomb Optical Company. Filed 4/2/23. Rare earths containing cerium, when added to a glass, decrease the transmission of ultra-violet light but cerium oxide or other cerium compounds produce an undesirable color.

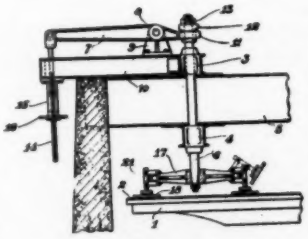
We have discovered that the use of antimony oxide in conjunction with cerium oxide will produce a glass which does not transmit ultra-violet light and will still be practically colorless even after exposure to sunlight for considerable periods.

The method of rendering glass containing cerium oxide unchangeable by the action of sunlight, consists in adding to the glass composition antimony oxide in sufficient quantity to accomplish this result without materially modifying it otherwise.

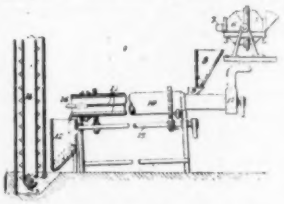
Various combinations of ingredients can be used with success. Our preferred batch is No. 1 in the table below.

	#1	#2	#3	#4	#5
SiO_2	70.92	71.54	68.16	69.65	71.07
Na_2O	14.60	14.82	14.12	14.43	14.72
B_2O_3	3.13	0.00	0.00	5.24	0.00
Sb_2O_3	9.46	2.38	15.90	9.29	9.47
CeO_2	1.89	1.91	1.82	1.39	4.74
CaO	0.00	9.35	0.00	0.00	0.00
	100.00	100.00	100.00	100.00	100.00

POLISHING MACHINE. 1,548,105. Aug. 4, 1925. Jacob Soderberg, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 7/5/23. In combination in a machine for polishing glass, a runner frame, a plurality of polishing runners having vertical spindles, pairs of parallel links each connected at one end to the frame and at the other to the spindle and arranged one above the other, and means whereby the connections between the lower links and the frame may be released to permit the spindles to be swung outwardly to inclined position to expose the lower surfaces of the runners for cleaning or repair.

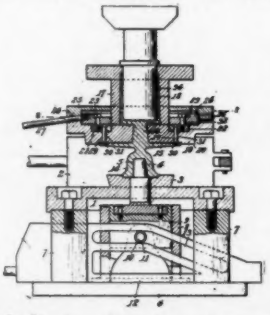


GLASS BATCH. 1,543,770. June 30, 1925. Otto W. Hilbert, Corning, N. Y., assignor Corning Glass Works. Filed 1/15/21. This invention refers to a method of preparing a glass batch from raw materials that are in the form of a fine powder, which consists in thoroughly mixing the materials, and then subjecting the mixture to heat of sufficient intensity to form the materials into small granules, each of which is composed of the desired proportions of raw materials.



PROCESS OF SEVERING GLASS. 1,548,108. Aug. 4, 1925. John A. Sweet, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 5/12/21. A process for severing glass such as that produced by a continuous drawing operation, which consists in applying to the article an electrically heated severing element maintained at a temperature such and applied for a period of time such that it melts its way through the glass.

GLASS-MOLDING APPARATUS. 1,543,725. June 30, 1925. Calvin B. Roe, Moundville, W. Va., assignor to Fostoria Glass Co. Filed 12/26/24. This invention provides a mold mechanism for shaping a candle holder and a bobeche in a single piece, including devices for forming in the bobeche the usual perforations for the reception of pendent-suspension wires and means whereby said devices may be promptly freed from the glass. It includes a sectional hinged mold, a valve operable into co-operative relation to the mold, a ring having a plurality of fixed pins depending vertically therefrom and a rotary device for elevating and lowering the pins.



Glass Factory Equipment and Supplies

Most of the information printed in this department comes direct from the manufacturers of the products described.

New Brown Recording Pyrometer

A new recording pyrometer which it is stated combines with highest accuracy a combination of unusually desirable features, has been developed during the past five years by the research department of The Brown Instrument Company, Philadelphia, Pa., who have been making pyrometers for sixty-five years.

Many features in the recording pyrometer just developed are radically new and patents have been applied for covering these improvements, some of which are listed below.

The new recorder has a die-cast black enameled aluminum case. The dimensions are 15" high, 14" wide and 9" deep, requiring a minimum amount of wall space considering the unusually wide 7" chart. (Fig. 1).

The instrument is built to make a single record, a duplex record with two records side by side, or in multiple form produces as many as 12 records on one chart.

It operates on the frictionless principle in which a pointer swings freely and at intervals of every thirty seconds is depressed

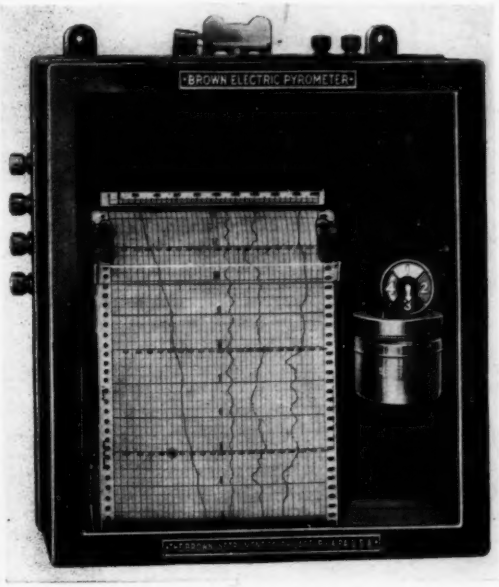


FIG. 1. NEW BROWN RECORDING PYROMETER

on a carbon or inked ribbon producing a mark on the chart. These marks are so close together as to form a continuous line. The marking ribbon and chart last two months before renewal is required and no inking is necessary.

The marking ribbon is above the paper so that the mark is produced on the front side of the paper where it shows clearly. The marking ribbon in the single and duplex recorder after each mark on the chart is moved back disclosing the last impression so that the record is clearly visible immediately after it is produced. (Fig. 2).

The galvanometer and the recording chart mechanism is carried on a hinged frame. When swung aside, the galvanometer is instantly accessible, and when closed a housing protects the galvanometer. (Fig. 3).

A glass knife edge is furnished for tearing off the paper and is located directly below the driving roll. The paper can be torn off two hours after the last impression is made. For example, a complete record for the previous 24 hours and ending 6:00 a. m. can be torn off about 8:00 a. m. (Fig. 4).

A platen is supplied on which notes can be recorded on the chart with pen or pencil. (Fig. 5).

In addition to recording the temperature on the chart, an indicating scale is provided with large figures legible at a considerable distance. The chart has rectangular coordinates. The time lines are straight across the chart and not curved as in other instruments.

The recorder is driven by an electric clock if alternating current is available. The current consumed by this clock is only four watts. Six recorders only consume the current required by the common 25-watt incandescent lamp. The electric clock eliminates hand winding and no governor or other means is needed to secure

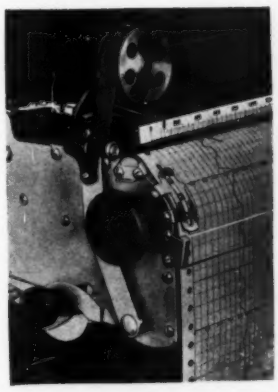


FIG. 2. RIBBON MOVED BACK MAKES RECORD VISIBLE

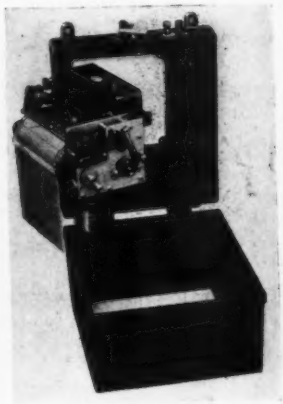


FIG. 3. RECORDER OPENED UP TO SHOW ASSEMBLY

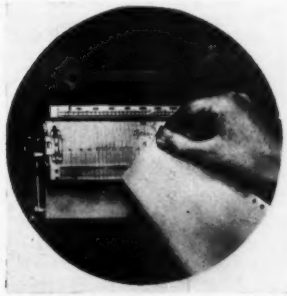


FIG. 4. GLASS TEAR-OFF FOR CHART

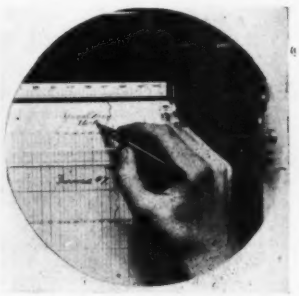


FIG. 5. SUPPORT FOR WRITING NOTES ON CHART

accurate timing. Where alternating current is not available, a hand wound clock can be supplied.

The chart speed can readily be changed and is supplied for a number of combinations. The standard chart speed is one inch an hour but by reversing two gears a speed of four inches per hour is obtainable. Speed combinations are available from one-quarter inch an hour to six inches per hour.

With a standard chart speed of one inch per hour, about 12 hours of chart is visible through the front of the case.

The instrument as a pyrometer incorporates automatic cold junction compensation including the Brown patented index for adjusting a compensated pyrometer to the correct initial starting point on open circuit.

A re-roll attachment is furnished where desired to roll up the chart automatically over a long period of time.

As a multiple recorder, this instrument incorporates an automatic switch with gold contacts mounted on bakelite and immersed in oil, which prevents any possibility of tarnishing of the contacts from corrosive gases in the atmosphere. Solenoids, speed control governors, and hand winding are eliminated.

The Glass World and What It Is Doing

News of the Industry

Glass Container Association to Collect Statistical Information

At the summer meeting of the Glass Container Association, held at the Marlborough-Blenheim Hotel, Atlantic City, N. J., Thursday, July 30, 1925 several topics of importance to the trade were discussed.

After a few preliminary announcements by President Ferguson, Dr. Lewis H. Haney, director of the Bureau of Industrial Research of New York University, gave a survey of the work which the University is doing in gathering, interpreting and disseminating information regarding a number of industries in the United States. He emphasized the necessity for an industry to have intelligent and complete information for its proper progress and illustrated the different points raised in his talk by enumerating the experiences of certain industries. Dr. Haney's talk was full of facts and was listened to with great interest by the members.

President Ferguson then discussed briefly an idea which had been suggested that the individual members of the association erect on their premises, near their factories or offices, a sign-board carrying the slogan of the Glass Container Association "See What You Buy—Buy in Glass."

Mr. Siegle, representing the General Outdoor Advertising Company, exhibited a miniature sign-board which he had constructed, showing an illustration of glass-packed foods and carrying the association slogan.

Mr. Ferguson stated that this matter had been referred to the publicity committee by the board of directors to make suggestions as to how the details of the plan could best be carried out, and that he hoped all members of the association would co-operate in giving publicity to the glass container when they learned the plans of the publicity committee.

The suggestion aroused interest and there was a short discussion of the possibilities of doing outdoor advertising but no action was taken.

STATISTICAL WORK DISCUSSED

President Ferguson then introduced the main subject of the meeting, that of the advisability of the Glass Container Association inaugurating statistical work. He pointed out that the uncertainty regarding the legality of statistical work had been cleared up by the decisions of the Supreme Court of the United States in the maple flooring and cement cases, rendered on June 1st, 1925. The board of directors therefore felt that it would be of benefit to the glass container industry to gather and disseminate statistical information and had drawn up recommendations and a tentative plan for the carrying on of this work. Briefly they recommended that the work be carried on by a special department in the association to be under the supervision of a special committee and that the cost of the work for the first year be borne out of the general fund of the association. Forms outlining the plan, together with a sheet of classification definitions were then distributed. It was explained that final forms would be drawn up by the director of the statistical department and the committee but that the forms distributed would serve as basis to work on.

A motion to adopt the recommendations of the board of directors for the creation of a statistical department was adopted and the work of gathering of statistical information will be begun at once.

The question was then raised as to whether work on cost accounting should not be undertaken also but it was explained that the board of directors felt that the statistical work should be inaugurated before September 1st, and for the present it was thought advisable to take up the statistical work only.

It was pointed out that if the work was to be of benefit it would necessitate the co-operation and full support of all, and the members present took a standing pledge to enter whole-heartedly into the work.

The employment of Fred J. Rummel to take charge of the Statistical Department was approved.

Less Foreign Business in Glass During Last Year

The United States Government's summary of glass and glassware imports and exports for the month of June, 1925 (see page 210 this issue), completes the fiscal year, 1924-1925, and shows that there was a heavy falling off from the imports of the year ending June 30, 1924. The decline amounted to $7,114,643. The decline was due principally to a reduction of $8,250,264 in the value of plate glass imported during the fiscal year, the total for that period being but $7,613,921, compared with $15,864,185 for the year ending with June, 1924, and $10,148,548 for the year ending June, 1923.

Part of the eight-and-a-quarter million dollar decline in plate glass imports was compensated for by gains made in the value of imports of other types of glass and glassware, so that the net total decline in all glass imports was smaller than that of plate glass alone.

It is interesting to note that the total value of plate glass imported during the year ending June, 1925, divided by the number of square feet gives an average value of 50 cents per square foot, while the average value of the plate glass imported during the year ending June, 1924, was approximately 63.9 cents per square foot.

The imports of cylinder, crown and sheet glass during the last fiscal year ending June, 1925, amounted to 41,503,325 lbs., valued at $2,235,836, an increase of $317,129 over 1924. There was a decrease of about $20,000 in the value of containers—vials, jars, etc.—brought in during the year just past. An increase of $450,819 took place in the value of imported cut and decorated glassware. Imports of miscellaneous glassware declined $459,338. Comparative figures for other products are given in the table on page 210.

The total exports of glass products for the fiscal year ending with June, 1925, amounted to $8,639,633 compared with $9,843,150 in the previous year, a difference of $1,203,517. There was a comparatively small decrease in the value of window glass, glass containers, table glassware, lamp chimneys, lantern globes, and shades for lighting fixtures. There was a decrease of $100,000 in exports of lamps and illuminating ware. Plate glass exports declined from $614,456 to $427,909. There was a small increase in the exports of chemical and electrical glassware and a decline of about $340,000 in miscellaneous glassware.

The report for the month of June, 1925, the last month of the fiscal year, shows a decrease in imports of $496,513, compared with June, 1924, of which $315,170 or approximately 63 per cent is accounted for by the decline in imports of plate glass. There was only an insignificant change in the value of exports for June, the total of $721,343 being about $54,000 less than June, 1924.

Fall Meeting of American Ceramic Society

The fall meeting of the American Ceramic Society will be held on October 1st, which will be Ceramic Day at the Exposition of Chemical Industries, Grand Central Palace, New York. Some of the papers on chemical engineering practice to be presented during the convention are: "Screening, Grading and Classifying," by Albert R. Reed of W. S. Tyler Company; "Handling of Materials—Intraplant Transportation," by A. E. Marshall of the Corning Glass Works; "Ceramics in the Chemical Plant," by Ross C. Purdy, and "Pyrex Glass" by A. E. Marshall.

Eastern Glass Distributors' Fall Meeting

The Eastern Division of the National Glass Distributors' Association will hold its fall meeting at the Hotel Traymore, Atlantic City, N. J., September 23 to 25. On Wednesday, September 23, the Eastern Executive Committee will give a dinner for members only; on Thursday morning the general meeting will be held followed by a luncheon, and in the evening a dinner and dance at the Traymore. On Friday there will be a golf tournament at the Country Club.

Hartford-Empire Buys Feeder Patents

The Hartford-Empire Company, Hartford, Conn., has purchased the United States patents and patent applications of the William J. Miller glass feeder.

The glass forming machine business and the foreign feeder and forming machine business heretofore conducted at Swissvale, Pa., by Mr. Miller will be continued, and feeder repair parts furnished by a new corporation, William J. Miller, Inc., under the management of Victor J. Greene, who has been associated in the business for many years.

It is reported that Mr. Miller has sold to Mr. Greene the two-story building on Center street, Swissvale, used for manufacturing purposes, for a consideration of $50,000.

The Miller Glass Engineering Company against whom a suit brought by the Owens Bottle Company is pending, which has not been withdrawn, announced to its customers that the sale of patent rights does not affect the suit or their contract rights. It is intended that when present service obligations are fulfilled the Miller Glass Engineering Company field service will be withdrawn.

The Hartford-Empire Company has also acquired by purchase the United States patents and pending applications of Tucker, Reeves & Beatty of Columbus, O., on the Tucker & Reeves feeder. This ends the litigation between the two interests and relieves the feeder patent situation, as a number of applications have been deeply involved in interference proceedings which have retarded the issuances of patents.

Progress of the Dunbar Flint Glass Corporation

A very interesting account of the progress of the Dunbar Flint Glass Corporation of Dunbar, near Charleston, W. Va., from a plant consisting of one building in 1911 to its present plant covering most of a 9-acre tract, was published in the Charleston, W. Va., *Gazette* of August 16. The company manufactures lamp and lantern chimneys, glass tumblers, vases, jars and similar goods. Recently it has developed a department for fine painted and decorated wares for which such a demand has been created that production has not been able to keep up with it.

A new and modernly equipped department is being added to production facilities which will materially increase capacity. The officers of the Dunbar Flint Glass Corporation are: James M. Payne, president, treasurer and general manager; Col. Abney Payne, a world war veteran, assistant general manager, and L. M. Riddle, general plant superintendent. W. D. Payne, a Charleston attorney, and the above officers constitute the board of directors.

Stinnes' Glass Works Using American Equipment

Four tanks, three of 300 tons capacity each and one of 400 tons, were put into operation in July manufacturing colorless glass bottles in the Glaswerke A. G. at Essen, Ruhr district, Germany. This factory is controlled by Hugo Stinnes. Automatic bottle machines are used. Automatic tube drawing machines installed some time ago are operating satisfactorily with so large a production that small independent producers are meeting with difficulty in competing.

Our correspondent states that construction of a plant for drawing sheet glass mechanically has been started but it will not, it is thought, begin manufacturing operations before the latter part of 1926.

Owens Bottle Increases Earnings

Net profit of the Owens Bottle Company and subsidiary companies during the first six months of 1925 amounted to $2,713,271.

Last year in the first six months the net profit amounted to $2,033,639, so that there is an increase in profit amounting to $679,632.

Manufacturing profit and royalties amounted to $3,982,003 for the six months ending June 30, 1925. Cash dividends received, interest and other income brought the total income to $4,187,287. General selling and contingent expense, discounts and other items brought the net earnings, before deducting federal income taxes, to $3,104,471. The federal taxes are estimated at $391,200, bringing the net profit to the figure announced.

Production of Plate Glass Breaks All Records

The production of plate glass in the United States during the first half of 1925 exceeded by 9,378,838 square feet the production for the first six months of 1924.

The figures for the first half of 1925 are 56,561,960 square feet. During the same period last year the production was 47,183,122 square feet. According to present indication, the plate glass turned out during the remainder of the year will make a total production for 1925 of between 105,000,000 and 110,000,000 square feet; or between 14,000,000 and 19,000,000 square feet more than was produced in 1924.

The growth of the plate glass industry during recent years is strikingly illustrated by the fact that more plate glass has been produced during the first half of the present year than was produced in the whole of 1921. The use of plate glass in the automobile and in large buildings such as office buildings, apartment houses and hotels has been largely responsible for this rapid growth.

In the last year or so, however, the increased use of plate glass in the windows of the medium class of homes has been an important factor.

New Plate Glass Plant Proposed

Reports to the effect that Van Tuyl, Heartt & Barron, industrial engineers of Detroit, Mich., are preparing plans for a new plate glass manufacturing plant to be erected at Rockwood, Mich., estimated to cost, including the power house and machine shop, about $5,000,000, are confirmed by F. F. Van Tuyl, with the reservation that no date for the starting of actual construction work has been set. A company has been organized to conduct the enterprise, headed by Gustav J. H. Peeters and Charles J. Pillow.

An improvement in the demand for plate glass during August resulted from the reduction of approximately 25 per cent in prices which was put into effect July 27 by the Pittsburgh Plate Glass Company and followed by the Standard Plate Glass Company and other producers. The demand for both plate and window glass continues to be active.

The National Window Glass Workers' wage committee failed to arrive at an agreement with the manufacturers' representatives at a meeting held in Cleveland, O., August 19. The manufacturers demanded 10 per cent off the present list, while the workers favored the present scale with 10 per cent off the fourth quality only.

Newspaper reports state that the American Building Corporation of Cincinnati, O., has taken the contract to erect 1,000 residences at a total cost of $75,000,000 at Coral Gables, a suburb of Miami, Fla. Construction of the first hundred houses will begin in September.

At the conference at Atlantic City between the National Bottle Manufacturers' Association and the Bottle Blowers Association the request of the workers for an increase in pay was denied.

A number of glass plants in Thuringia have been closed down and the industry is becoming increasingly concentrated.

Trade Activities

The Peter Hecht Glass Works, Inc., Philadelphia, Pa., has changed its name to the Penn Plate Glass & Mirror Company.

The New Cumberland Glass Company, New Cumberland, W. Va., is reported to have increased its capital stock from $25,000 to $150,000.

The Paterson Sash and Door Company, Paterson, N. J., has been incorporated with a capital of $100,000 by G. Green and J. Glazier.

The Model Window Glass Company plant at Fort Smith, Ark., is reported sold to the **Magnolia Window Glass Company** of the same city.

Zenor Bottle Company's glass plant, located at Fort Smith, Ark., is to be moved to Bristow, Okla., where it will be operated under the name of the Bristow Bottle Company.

The Gill Glass Company, Amber and Venango streets, Philadelphia, Pa., has awarded a general contract to William R. Dougherty, Philadelphia, for an addition to cost about $36,000.

The Opalite Corporation, 201-203 E. Ohio street, Chicago, Ill., was recently formed by Joseph A. and Philip E. Golde and S. Ruth to manufacture and deal in sheet and blown glass products.

The Deckers' Creek Sand and Stone Company, Morgantown, W. Va., in which the United States Window Glass Company has a controlling interest, is in the hands of J. M. Strouss, general manager, as receiver.

The Moonglow Cut Glass Company has been incorporated at Lancaster, O., with a capital of $25,000. The officers include: D. Shonting, president; E. M. Roberts, secretary and treasurer, and T. Poulson, factory manager.

The Hocking Glass Company, Lancaster, O., recently announced the taking over of the plant of the National Glass & Lens Company of the same city, on a one-year lease with the option of purchasing it at the end of that period.

The Feeder Patents Company was incorporated under the laws of Delaware on August 7 with a capital of $1,000,000 and with the stated purpose of manufacturing glass working machinery. No information is available as to the interests behind the organization.

M. F. Lefebvre Glass Company of South Vineland, N. J., has leased the factory in North Millville, N. J., formerly operated by the International Glass Company and will manufacture flat glass specialties, mirrors, push button plates, windshields, and also lenses.

A. & H. Vieth, New York, has been incorporated with 2,000 shares $100 par preferred and 2,000 shares no par common stock to manufacture and deal in glass and metal. The incorporators are: I. Jones and J. Leav, with B. Schwartz, 192 Broadway, New York, as attorney.

Salt Lake City newspapers report that the **McDonald Brothers Company** of Los Angeles, Cal., will abandon their glass plant there and erect a new one adjacent to a deposit of silica sand at Salt Lake City. The actual removal of the plant, it is stated, will not take place until next Spring.

The U. S. Forest Products Laboratory at Madison, Wis., announces the following dates for the fall group of instructional short courses in wood utilization: Gluing of Wood, September 14 to 19; Boxing and Crating, September 21 to 26, and Kiln Drying of Lumber, September 21 to October 2.

The Scohy Sheet Glass Company, Sistersville, W. Va., put their new Fourcault machines into operation and began early in August to produce and ship window glass. According to various engineers who have visited the plant the start was a very good one and it is expected that operations will be continued throughout the winter.

The Excella Glass Company, Henryetta, Okla., has arranged to move its plant to Okemah, Okla. Five acres of land have been donated to the company by one of the citizens of Okemah. New buildings will be erected and O. A. Truburn, president of the Excella Company, states that they are in the market for new equipment of all kinds.

The United States Glass Company has been incorporated in Texas with a capital stock of $10,000 by interests said to represent the United States Sheet and Window Glass Company, Shreveport, La. J. C. Blair and B. C. Root, both associated with the Libbey-Owens Sheet Glass Company, Toledo, O., are named as incorporators.

The Marienville Glass Company, Marienville, Pa., elected a new board of directors on August 12, as follows: R. R. Underwood, R. A. Dieble, T. J. Reyner, L. H. Mensch, D. E. Vogan, W. W. Wilson and W. H. Pickens. Mr. Underwood was made president; T. J. Reyner, vice-president, and R. A. Dieble, secretary-treasurer.

An application for the appointment of a temporary receiver for the **Baker Mould Company,** Dunkirk, Ind., has been filed in the Circuit Court by one of the local banks, which states that owing to disagreements between the stockholders and management the assets are being dissipated and a receiver should be appointed to conserve same for the creditors.

At a recent meeting of citizens of Kittanning, Pa., and representatives of interests which are endeavoring to organize a plate glass manufacturing concern and build a factory from plans prepared by H. L. Dixon Company, Pittsburgh, a six months option was given to the promoters on 60 acres of land, part of the site of the old fair grounds at Kittanning. The proposed plant will have an output of 5,000,000 sq. ft. of glass.

Davies Glass & Manufacturing Company's plant a Martin's Ferry, O., will, it is announced, be offered for sale shortly. Trustee A. L. Bumgarner has been authorized by the court to abandon the company's real estate to the bondholders. It is expected that the property will be placed in the hands of a committee of bondholders and if a satisfactory outright sale cannot be effected it is possible that the bondholders may arrange to lease the plant to parties who would take over and operate it.

The One-Piece Bifocal Lens Company, Indianapolis, Ind., the New Jersey Optical Company, Newark, N. J., the Simpson-Walther Lens Company, Rochester, N. Y., and the C. G. Aldrich Company, Boston, Mass., have been consolidated under a new organization, the **Continental Optical Corporation.** The factories operated by the four concerns will be utilized to produce a complete service including bifocal and single vision lenses, rims, spectacle mountings and cases, etc.

July construction contracts reached the highest July total on record, according to F. W. Dodge Corporation's review. Contracts in the 36 Eastern States (which include about 7/8 of the total construction volume of the country) amounted to $529,000,100. In only two previous months has this total ever been exceeded, April and June of this year. The decrease from June was only 2 per cent, while the increase over July of last year was over 53 per cent. There is usually a fairly considerable seasonal decline in July.

The Standard Plate Glass Company, Pittsburgh, has passed its regular quarterly dividend, the reason being, it was announced, that the profits had been reinvested in the business. The company's report for the quarter ending June 30, 1925, showed a net profit of $144,106 after depreciation, taxes and interest, equivalent to the usual dividend requirements on 7 per cent prior preference and 7 per cent preferred stock, and to 7 cents a share earned on outstanding 200,000 shars of no par common.

The Federal Light and Lens Corporation has been organized for the purpose of taking over the business and plant of the Star Glass Company, Star City, W. Va. The names of the incorporators have been announced as R. S. and H. A. Kauffield of the Star Glass Company; F. H. Mitchell, of Boston, Mass., and H. C. Mellinger, Johnstown, Pa. Two Kauffield patents, one for a globe and reflector and another for an automobile lens have been taken over by the new company. Manufacturing, it is reported, will begin in October. Enlarged business is expected and an increase in production facilities is being planned.

F. C. Terry, president of the **Lippincott Glass Company,** has issued an announcement to the trade stating that the most modern equipment obtainable is being installed in the plant at Alexandria, Ind., and that a complete line of the high grade tableware and decorative ware will be manufactured. A complete line of samples is now on display at the main office of the company in the First National Bank Building, Cincinnati, O. H. M. Anderson, vice-president, and well known throughout the glass industry, will supervise all manufacturing. Mr. Terry states that the same policy that has brought the new owners success in other lines will be strictly adhered to, that of giving proper service to the trade at any cost.

Personal Notes

L. H. Maxfield, formerly chief engineer of the Illinois Glass Company, Alton, Ill., has resigned that position and **Garland Lufkin,** formerly chief draftsman, has been appointed his successor.

P. Q. Williams, formerly general manager of the Charles Boldt Glass Company, Cincinnati, O., and inventor of well known lehr feeding mechanism, has resigned to accept a position with the Owens Bottle Company, Toledo, O. His place has been filled by Mr. Hess, formerly of the Owens Bottle Company.

G. B. Arthur, Chicago district manager of the Central Division of the National Lime Association, has been appointed assistant to the president, in direct general charge of all scientific, technical, research, field and general publicity work of the Association and its divisions.

Donald Robertson, whose interesting account of glass making in Indo-China appeared in the June issue, and who has been in charge of the plant of the Société Française des Verreries d'Indochine, Haiphong, has resigned from that organization and will arrive in the United States during October on his way to England where he will be connected with the Queensborough Glass Bottle Works, near London, as technical manager.

F. J. Andrews, who has been manager of the Okmulgee, Okla., plant of the Interstate Window Glass Company, has been named by the receivers of the company to be general superintendent of operations of the various plants of the company and has assumed the duties of the office. **Burress Moore,** formerly manager of the Monongahela City, Pa., plant of the American Window Glass Company, has been appointed by Mr. Andrews to be manager of the Interstate factory No. 1 at Kane, Pa. **Harley Swift,** assistant manager of the American Window Glass Company's Monongahela City plant, has been advanced to the position of manager.

What Our Advertisers Are Doing

The Amsler-Morton Company, Pittsburgh, Pa., report a satisfactory volume of inquiries and business. They state that the Amco recuperator tank built for the Victory Glass Company, Jeannette, Pa., has been placed in operation and the recuperator day tank for the Jeannette Shade & Novelty Company has been completed and the construction of another similar unit started. Five lehrs are being built at Swindell Brothers' factory, Baltimore, Md., and an Amco tank at the McKee Glass Company is rapidly nearing completion. The decorating lehr recently constructed for the Liberty Cut Glass Works is now in operation and an annealing lehr is completed and three tanks are under construction. A decorating lehr 8 ft. 8 in. by 97 ft. erected for the Indiana Glass Company will start in operation shortly. This is the seventh Amco lehr at this plant. The reconstruction of a large window glass tank for the Sandusky Glass Manufacturing & Supply Company is under way and will probably be completed early in September. Another large tank and gas producer plant is being erected by the Amsler-Morton Company for the Carr-Lowrey Glass Company, Baltimore, Md.

Recent Death

James Steadman, long active in the management of the Central Glass Works, Wheeling, W. Va., until his retirement last April, died on August 23 at his home in Wheeling.

Coming Meetings

AMERICAN CERAMIC SOCIETY fall meeting will be held in connection with the chemical exposition at New York City, October 1, 1925, and the annual meeting at Atlanta, Ga., February 8-13, 1926.

ASSOCIATED GLASS AND POTTERY MANUFACTURERS AND PITTSBURGH GLASS AND POTTERY EXHIBIT, January 11 to 30, 1926, at Pittsburgh.

THE WESTERN DIVISION of the NATIONAL GLASS DISTRIBUTORS' ASSOCIATION will hold its fall meeting at Chicago, September 11 and 16. The Eastern branch of the association will hold its fall meeting at Atlantic City, September 23 to 25.

The annual convention of the AMERICAN BOTTLERS OF CARBONATED BEVERAGES will be held at Kansas City, Mo., October 19 to 23.

TENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held at Grand Central Palace, New York, September 28 to October 3.

THE FOURTH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace, New York, November 30 to December 5.

THE STAINED GLASS ASSOCIATION OF AMERICA, formerly the National Ornamental Glass Manufacturers Association, will hold its next annual convention in the summer of 1926 in Washington, D. C., which will be followed by a trip to Europe.

What the World Wants

Specific inquiries for American goods received in the Department of Commerce

Argentina. 16081, glass for protective screens for X-rays.
India. 16077, glass, window, ribbed and figure rolled.
Peru. 16164, glass tubing for gas.
Ceylon. 16287, glassware.
Chile. 16449, window glass.

The Bureau of Foreign and Domestic Commerce, Washington, D. C., has ready for distribution a list, LA-30110, of China, earthenware, glass and glassware importers and dealers in Mexico.

Inquiries Received

For Further Information Address THE GLASS INDUSTRY

281. (Brazil). We would like quotations on the following equipment to replace that of the glass finishing department of our client's factory in Brazil which was destroyed by fire: needle etching machines, fluorhydric vats, baking ovens for painted and enameled ware, glass "forges" of all sizes, horizontal cracking off machines for lamp chimneys and other long cylindrical ware, hand cracking off machines for tumbler and stem ware, grinding and glazing machines for tumbler and stem ware, engraving stands, cut glass grinders and cutters, large horizontal roughing and smoothing mills, sand blast machinery, etc. All offers should be made in triplicate and include export packing. If offers are not made F. A. S. New York, the freight rate to New York should be given as well as full packing information (size of boxes, weights, etc.). G. Muntz, Pres., Tropenas Co., 25 Broadway, New York. (Aug. 17).

282. We are in the market for a quantity of glass shapes for use in conjunction with the manufacture of spherical or parabolic glass reflectors. These shapes should either be ground to conform with our specifications or be bent from thin polished plate in metal forms. (Aug. 15).

283. We would like the names of manufacturers of glass push button plates. (Aug. 13).

284. Will you please give us a list of concerns making blowers or fans for glass factories. (Aug. 4).

285. (From England). Can you give us the names of American firms manufacturing motor lamp and bicycle lamp glasses and who would be interested in exporting same in large quantities. (Aug. 5).

286. We are in the market for window glass manufacturing equipment for a new factory. (Aug. 17).

287. Kindly give us the names of manufacturers of glass ink wells. (Aug. 20.)

288. We are desirous of obtaining quantities of flint glass tubing, 2¾ in. inside diameter, ¼ in. wall, 76 in. length, with perfectly smooth surface. (Aug. 24).

Glass Stock Quotations

Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.

PITTSBURGH STOCK EXCHANGE, AUGUST 21, 1925

	Bid	Ask	Last
American Window Glass Machine, common	93	95	93
American Window Glass Machine, pfd	95	95½	95
American Window Glass, preferred	113	117	115
United States Glass	13	14	13½
Pittsburgh Plate Glass	275	282	280
Standard Plate Glass, common	6½	7	6¾
Standard Plate Glass:			
Preferred cumulative	48	52	50
Prior	80½	90	81

Glass stocks on the Pittsburgh Exchange showed little change during August. Demand for plate glass continues to be strong. Curtailment of automobile production has been much less than had been expected and as a result demand for plate glass in that branch has been highly satisfactory.

WHEELING STOCK EXCHANGE, AUGUST 21, 1925

Hazel-Atlas	35½	..	36½
Imperial	..	72	72
Fostoria	140	..	150
Central	..	95	105

The Wheeling stocks showed a slight improvement in price due to improved conditions throughout the machine made glass industry. Operations are over 70 per cent.

TOLEDO STOCK EXCHANGE, AUGUST 21, 1925

Owens Bottle Machine, common	54½	55	55⅛
Libbey-Owens Sheet Glass, common	198	201	200
Libbey-Owens Sheet Glass, preferred	114	116	115

Current Prices of Glass-Making Materials

Quotations furnished by various producers, manufacturers and dealers.

August 21, 1925

		Carlots	Less Carlots
Acid:			
Citric	lb.	..	.46
Hydrochloric (HCl) 20° carboy ext.	lb.	..	.02
Hydrofluoric (HF) 60% (lead carb.)	lb.	..	.13½
52% and 48%	lb.	..	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		..	5.25
Sulphuric (H_2SO_4) 66°	ton	15.00	..
Tartaric	lb.	..	.29
Alcohol, denatured	gal.	..	.65
Aluminum hydrate ($Al(OH)_3$)	lb.	.06	.07
Aluminum oxide (Al_2O_3)	lb.	..	..
Ammonium fluoride (NH_4F)	lb.	..	.23
Ammonia water (NH_4OH) drums	lb.	..	.05-.06¼
Antimony, metallic (Sb)	lb.	..	.18
Aluminum oxide (Al_2O_3)	lb.	..	.18½
Antimony sulphide (Sb_2S_3)	lb.	..	.18
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$)			
Precipitated	ton	..	..
Natural, powdered	ton	42.00	45.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05
Barium nitrate ($Ba(NO_3)_2$)	lb.	..	.09
Barium selenite ($BaSeO_3$)	lb.	..	..
Bone ash	lb.	.05½	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.04¾	.05
Boric acid (H_3BO_3)	lb.	.09	.09¾
Refined	lb.	..	..
Cadmium sulphide (CdS)—			
Red	lb.	..	1.25
Orange	lb.	..	1.10-1.25
Yellow	lb.	..	..
Chromium oxide (Cr_2O_3)	lb.	.31	.33
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.25
Black prepared	lb.	..	.30
Cryolite ($Na_3Al\ F_6$)	lb.	..	.09⅛
Epsom salts ($MgSO_4$)	Per 100 lb.	..	1.40
Feldspar—			
100 mesh	ton	12.50	16.00
80 mesh	ton	..	..
40 mesh	ton	..	..
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	40.00	..
" " 90%	ton	38.00	..
Formaldehyde	lb.	.08¾	.09¼
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	ton	..	.02
Black (FeO)	ton	..	..
Kaolin (f.o.b. mine)	ton	10.00	..
English, lump, f.o.b. New York	ton	14.00-23.00	..
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.12	.12
Litharge (PbO)	lb.	.11½	.11½
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)	lb.	..	..
Magnesia (MgO)—			
Calcined, heavy	lb.	..	..
Light	lb.	..	..
Magnesium carbonate ($MgCO_3$)	lb.	.03¼	.03½
Manganese 85% (MnO_2)	lb.	.03½	.03¾
Nickel oxide (Ni_2O_3), black—			
for nickel content	lb.	..	.35
Nickel monoxide (NiO), green—			
for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	19.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	..	.08¾
Ground	lb.	..	..
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06¾	.07¼
Hydrated 80-85%	lb.	.05¾	.06
Potassium chromate (K_2CrO_4)	lb.	..	..
Potassium hydrate (KOH) (caustic potash)	lb.	..	.07⅛-.07⅝
Potassium nitrate (KNO_3) (gran.)	lb.	.06⅛	.06⅜
Potassium permanganate ($KMnO_4$)	lb.	.14½	.16
Powdered blue	lb.	..	.24-.28
Rochelle salts, bbls.	lb.	..	.20
Rouge	lb.	..	..
Rutile (TiO_2)	lb.	..	..
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	2.10
Silver nitrate ($AgNO_3$)	oz.	..	.49⅝
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat per 100 lb.	1.40	..
Bulk, on contract	Flat per 100 lb.	1.35	..
In barrels	lb.	1.69	2.40
In bags	lb.	1.45	..
Spot orders	.05 per 100 lbs higher		
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	..	.06¾
Sodium hydrate (NaOH) (caustic soda)	Per 100 lb.	3.20	3.90
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04⅛
95 per cent	Per 100 lb.	2.47	2.65
Sodium selenite (Na_2SeO_3)	lb.	..	..
Sodium fluosilicate (Na_2SiF_6)	lb.	..	.04¾
Sodium uranate (Na_2UO_4)	lb.	..	1.15
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35-3.65	3.75-3.90
Flowers, in bags	Per 100 lb.	3.00-3.30	3.40-3.55
Flour, heavy, in bbls.	Per 100 lb.	2.50-2.80	2.90-3.05
Tin chloride ($SnCl_2$)) (crystals)	lb.	..	.41
Tin oxide (SnO_2) in bbls.	lb.	..	.62
Uranium oxide (UO_3), 100 lb. lots	lb.	..	1.15
Zinc oxide (ZnO)	lb.	.07½	.07¾

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to July 24, 1925.

	June 1924 Quantity	June 1924 Value	June 1925 Quantity	June 1925 Value	Twelve Months Ending June 1924 Quantity	Twelve Months Ending June 1924 Value	Twelve Months Ending June 1925 Quantity	Twelve Months Ending June 1925 Value
Glass and glass products (total)	.....	$775,535	.....	$721,343	.....	$9,843,150	.....	$8,639,633
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,107	8,316	3,206	18,227	47,781	215,889	34,465	179,559
Plate glass, unsilvered, sq. ft.	224,797	50,353	114,287	41,228	1,736,251	614,456	1,536,734	427,909
Other window and plate glass, n.e.s. lbs.	132,526	17,715	286,406	30,016	2,234,935	254,309	2,161,346	226,438
Glass containers (bottles, vials and jars) lbs.	5,005,478	277,699	6,229,056	264,723	64,101,282	3,152,049	67,705,864	3,006,011
Table glassware, plain lbs.	1,426,005	173,820	1,146,695	116,448	18,246,026	2,065,648	16,970,069	1,736,390
Table and other glassware, cut or engraved lbs.	44,778	13,925	37,790	12,805	527,861	172,916	582,187	171,840
Glassware for lighting—								
Lamp chimneys and lantern globes lbs.	157,054	29,345	164,147	28,803	1,999,454	377,877	1,962,840	341,217
Globes and shades for lighting fixtures lbs.	74,361	21,340	129,610	39,199	1,592,809	456,717	1,484,587	433,006
Lamps and other illuminating devices, chiefly of glass lbs.	99,926	28,442	87,322	26,989	1,373,005	355,292	880,899	256,252
Chemical glassware lbs.	16,041	15,226	15,962	13,658	247,146	181,711	247,474	194,094
Electrical glassware, except for lighting lbs.	434,959	32,678	156,590	15,870	2,794,471	228,365	2,545,475	240,017
Other glassware, n.e.s. lbs.	544,754	106,676	502,156	113,377	10,797,882	1,767,921	6,997,392	1,426,900

IMPORTS

Corrected to July 24, 1925.

Glass (total)	.....	2,039,164	.....	1,542,651	.....	$24,502,033	.....	$17,387,390
Cylinder, crown and sheet—								
Unpolished, lbs. dut.	4,171,398	240,056	3,496,799	188,020	36,313,747	1,918,707	41,503,325	2,235,836
Bent, ground, beveled, colored, painted, etc., and polished dut.	.....	34,587	.....	48,401	.....	690,422	.....	535,600
Plate glass—								
Unsilvered, sq. ft dut.	1,785,007	1,112,592	1,654,914	797,422	24,810,592	15,864,185	15,112,213	7,613,921
Fluted, rolled, etc., or silvered, or containing wire netting, sq. ft. dut.	378,517	51,580	163,770	18,935	2,624,697	376,992	1,683,000	263,669
Containers—bottles, vials, etc. dut.	.....	13,351	.....	10,004	.....	190,140	.....	169,398
Table and kitchen utensils, lbs. dut.	196,263	45,681	68,961	16,014	943,745	206,096	590,221	147,172
Glassware, cut or decorated, lbs. dut.	336,312	162,668	323,143	177,801	3,728,096	1,670,446	4,107,043	2,121,261
Blown glassware, n. e. s., lbs. dut.	.....	.....	.....	.....	[3]3,402,894	[3]881,319	.....	.....
Bottles, ornaments, etc., lbs. dut.	671,615	205,372	361,583	89,597	[2]1,834,020	[2]618,539	5,779,071	1,641,048
Bulbs or electric lamps, number dut.	799,497	14,055	1,576,880	17,195	[2]6,396,278	[2]91,861	19,266,546	211,532
Chimneys, globes, shades, etc., lbs. dut.	280,483	62,081	317,037	70,779	[2]2,275,185	[2]370,209	5,045,636	1,126,860
Articles and utensils for chemical, scientific, and experimental purposes, lbs. dut.	81,020	22,449	76,568	31,549	[2]473,185	[2]157,509	884,500	314,823
Other glassware dut.	.....	74,692	.....	76,934	.....	1,465,608	.....	1,006,270

[1] July 1, to Dec. 31, 1923. [2] Beginning Jan. 1, 1924.